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CIVIL ENGINEERING.

*The Relative Efficiency of the Screw and Paddle Wheel when applied to Vessels of Identical Form, Tonnage, and Steam Power, independent of the use of Sails.**

The comparative results of the *Himalaya* and *Atrato* afford the best opportunity of testing the relative efficiency of the screw propeller and paddle wheel, and examples for exhibiting the system proposed in the Arithmetic of Naval Architecture, by which the economy of the engines can be calculated by means of the formula $V^2 = \frac{2}{3} \frac{\text{Ind. H. P.} \times 100}{\text{Mid. Sec.}}$.

The Himalaya.

Displacement,	3220 tons.
Nominal H. P.,	700
Ind. H. P.,	2050
Midship section,	560 sq. ft.
Draft of water forward,	15 ft. 3 ins.
Draft of water aft,	18 ft. 3 ins.
Rate in statute miles,	15·87
Rate by formula,	15·75
Consumption of coals,	80 tons per day.

The effective H. P. required for the above midship section, and rate by the formula (conceded as a standard), is 1367, and £50 per nominal H. P. taken as a basis for testing the economy of the engines, the value of the E. H. P. becomes £25 12s. per horse; and assuming 15·87 miles as her working rate, as an example, the consumption of E. H. P. is 5·4 lbs. per hour, or one ton of displacement carried one mile, by the consumption of ·146 lbs. of coal, at the rate of 15·87 miles per hour.

* From the Lond. Artizan, April, 1857.

	Atrato.
Displacement,	3070 tons.
Nominal H. P.,	900
Ind. H. P.,	3070
Midship section,	544
Draft of water forward,	16 ft. 4 ins.
Draft of water aft,	16 ft. 8 ins.
Rate,	16·08 miles.
Rate by formula,	19·40 "
Consumption of coals,	96 tons.

In this vessel, the E. H. P. required for the above rate and midship section is 1403, therefore, with the previous suggestion, the value of that power becomes £32 1s. per horse, the consumption of E. H. P. 6·3 lbs. per horse, or 1 ton of displacement, carried 1 mile, by the consumption of ·181 lbs. of coal, the efficiency and economy of the two vessels would stand thus :—

	Himalaya.		*Atrato.*
Value of engine,	£25 12s.	. . . .	£32 1s.
Consumption of E. H. P.,	5·4 lbs.	. . . .	6·3 lbs.
One ton of displacement carried 1 mile,	·146 lbs.	. . . .	·181 lbs.
Ratio of actual weight to formula speed,	100	. . . .	83

Therefore, the engine of the *Himalaya* is 20 per cent. cheaper than that of the *Atrato*, the consumption of E. H. P. 14 per cent. less, the displacement carried about the same, and the efficiency for speed of the *Atrato* 17 per cent. less than the *Himalaya ;* consequently, in these examples, the screw is more efficient and economical than the paddle in every respect.

Mr. Scott Russell said the matter stands thus: let it be supposed that there has to be propelled 1 ft. square of midship section at the rate of 5 miles per hour, and another at the rate of 10 miles per hour, then if the resistance to that square foot at 5 miles per hour be 5 lbs., according to the usual known law of the resistance being as the square of the velocity, the resistance at 10 miles would be 20 lbs.; but this resistance of four times that amount is acting over double space in an hour, and therefore they must take the four and double it again, for the measure of the power *developed* in that time necessarily and unavoidably as the cube of the velocity.

The use of the word "power" amongst engineers was the force developed for an hour or for a day; at all events, it was the power developed in a given time, and this consisted of two elements, viz: force, and the space moved over.

Everybody puts engines in a vessel upon the principle, that the resistance increased as the square of the velocity, and the H. P. as the cube of the velocity.

Mr. R. Griffiths said, having myself been present at the experiments that were made on her Majesty's ship *Flying Fish*, at Portsmouth, there appears to me much more valuable information to be derived from those trials, bearing upon the subject under discussion, than was stated here last Tuesday by Mr. Samuda ; so much so, that it clearly proved to my mind that *neither the square nor cube* of the power is correct, with regard to increased speed to be obtained by vessels on being propelled through

the water. The *Flying Fish* is built with beautiful lines both at the bow and stern, and when tried on July 3d, the engines made 74½ revolutions per minute, Ind. H. P. 1106·06, which gave her a mean speed of 11·603 knots; and with three-quarter power, or 68¼ revolutions, Ind. H. P. 877·0, gave a speed of 11·201; and at half power, or 59 revolutions, and 576 Ind. H. P. gave a speed of 9·923 knots: thus, while the power was doubled, the increased speed was only 1·680 knots, which considerably exceeds even the cube of the power.

After this she had a temporary bow fitted on, so as to give her a finer entrance; but no other alteration whatever was done, and on September 16th again tried, when the engines made 77 revolutions, Ind. H. P. 1309, which then gave her a mean speed of 12·572, and with three-quarter power, or 68 revolutions, and 918·72 Ind. H. P., gave a speed of 11·150, and at half-power or 60 revolutions per minute, Ind. H. P. 660·18, a speed of 10·120; thus, by doubling the power with the false bow, gave her an extra speed of 2·452 knots, or just what was due to the cube of the extra power exerted. But the most interesting fact is, that when working at half and also at three-quarter power, no increase of speed was obtained from the application of the temporary bow, while with full power an increase of nearly one knot was obtained. This, I think, must be evident to all parties, that the form of the ship ought to be made suitable to the power intended to be applied to her; and until naval architects are able to solve this important point, we are doomed still to proceed by the old rule of thumb and haphazard system of building ships.

Mr. Bidder's observation last Tuesday evening, on the great advantage obtained in speed by large vessels over small ones, relative to the power exerted, does not appear to me to be correct, for the same advantage is obtained by the large vessel in smooth as well as rough water, or, were the advantage due to momentum, even in rough water the smaller vessel might be made equal to the larger one, by simply giving her a heavy fly-wheel on the driving shaft; but that no advantage could possibly result by so doing should be evident to every one; the advantage gained is due to quite another source; a ship in being propelled through the water, strikes it with her bow from a state of rest into motion, and when it is once put in motion, the power required to keep it up is much less in proportion than was required to start it. Since both the small and the large vessel has to divide and set the water in motion; it is clear how the large vessel gets so great an advantage over the small one. I will now bring a case before you, which, I think, proves the correctness of this theory.

Last month Messrs. Summers and Day, of Southampton, fitted one of my screws to the screw steamer *Dane*, of 40 H. P., 500 tons measurement; her original screw was 10 ft. 6 in. diameter, 18 ft. pitch, with three blades, each 3 ft. 4 in. wide at the points, and 1 ft. 10 in. at root, which gave the vessel a speed at the measured mile of 8·50 knots. The object in applying my screw was to enable the ship to sail with the screw fixed, and it was, consequently, made as narrow as possible, so that it occupied but a very little more space than the width of the stern post, looking fore and aft, the diameter and pitch being the same as the three-bladed screw; but the points of the blades were only 9 ins. wide, and

3 ft. at the root. Now, with only this narrow strip of a blade, the vessel made 8·675 knots, the pressure, vacuum, draft of water, and all other circumstances being alike, the only difference being, the two-bladed narrow screw made six revolutions more per minute, which was partly, if not altogether, due to the diminished friction and increased speed of vessel, as compared with the three-bladed screw. Now, if the 9 in. surface on each of the two blades gave as much resistance to the power exerted, as was offered by the 3 ft. 4 in. on each of the three blades, what could the extra surface on these blades be doing?

There is also another very interesting fact proved at the *Flying Fish* trials, that considerably more resistance is offered by the water to the blades of the screw, when set at an incline towards the ship, instead of being at right angles with the screw shaft. The screw I made for the *Flying Fish* had two sets of blades made for it, the one set being at right angles with the shaft in the ordinary way, the other fixed at an angle of about 18° towards the ship, and with these blades at 16 ft. pitch, held the engines at 77·3 revolutions, Ind. H. P. 1·265, and with the blades set at right angles with the shaft; they required to be 20 ft. 6¼ ins. pitch, the engines making 75½ revolutions and 1281·8 Ind. H. P., the result in speed being slightly in favor of the straight blades. I shall here draw your attention to the fallacy engineers have fallen into regarding the slip, as it is termed, of the screw; for in this case one screw had 4·146 ft. more slip in every revolution than the other, and yet gave a better result in propelling the vessel in proportion to the power exerted; the fact being, that whether the vessel is moored or under weigh, the slip (or what is more properly termed the water which is forced through the screw) is the same, and must be in proportion to the power exerted.

I will give you, *per contra*, another instance of the effect the pitch of a screw has with regard to the speed obtained relative to the power employed.

In January last I had a letter from Mr. Frederick Bramwell, of Bridge Street, Engineer, giving me the result of a trial he had just made with one of my screws on the steamship *Augusta*, of 60 H. P., into which he had been putting new boilers, and doing other repairs. The owners were desirous to increase the pitch of the screw, as they were under the impression it would improve the speed. The screw was 5 ft. 6 ins. diameter, and Mr. Bramwell had it set at 11 ft. 3 ins. pitch at the points of blade, and when tried at her moorings the engines made 116 revolutions per minute, but when under weigh they only made 110, and when tried at the measured mile at Long Reach, with 110 revolutions, the ship gave a mean speed of 6·385 knots. Mr. Bramwell from prior experiments he had on other vessels with my screw, could perceive from the wake-water the screw was not doing its duty; he therefore had the vessel run on the beach, and altered the pitch to 10 ft. 3 ins. at points of blade, and then went again on the measured mile. The engine again made 110 revolutions, steam and vacuum the same as first trial; but the ship now gave a mean of 7·9 knots; and, as Mr. Bramwell observed, had the screw been cast in one piece, it is probable the owners would not have allowed the ship to be detained to get another screw cast, and the vessel might have worked for years at a loss of 1½ knots in her speed, wasting fuel, oil, &c., to no purpose.

Experience has taught engineers what pitch to put on a screw so as to hold the engines at very near the required speed ; but they have not yet learned how to fix upon the best pitch that will give the best result in propelling the ship, relative to the power exerted, any more than has the ship builder in giving the best form to the vessel, for obtaining the greatest speed relative to the power applied.

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*On the Circumstances which appear to limit the maintenance of Higher Speeds than are now attained by Steamships in Deep Sea Navigation, and an Inquiry into the Causes which have hitherto prevented the asserted High Speeds of Steam Navigation on the American Rivers from being arrived at in England.** By Mr. R. ARMSTRONG.

In the explanation of the above circumstances, the first application of the established principles of science is of absolute importance. When those principles are clearly proved to be at fault, then it will be time to assert that the science of naval architecture receives no assistance in the "why and the wherefore" for the formation of vessels; but until then the safest calculations are those made on the firmly-established principles of mechanics and hydrostatics. By merely accepting those principles, we reduce the whole art of naval construction, and an answer to that most important subject to a simple mathematical calculation; and what is of the most primary importance, the separation of the performances of the machinery from the question of the form in the calculations of velocity.

The science of mechanics asserts that with a given power the velocity is in proportion to the weight to be removed—the less the weight the greater the velocity of that power; it asserts that the inclined plane cannot decrease the weight, and it most emphatically asserts that the theory of the wave—convex, concave, or any other form of water line—for producing less resistance to a vessel passing through the water, is the grossest delusion of the nineteenth century.

The science of hydrostatics asserts that the resistance is as the square of the velocity—the propelling power to overcome that resistance the same—and not as the cube, which is the prevailing opinion at present with respect to steam navigation.

In seconding these assertions of science, every available data shall be produced in preference to arguments to establish the value of the following formula for every requirement, for any rate of sailing, they are based on the fundamental law of hydrodynamics for calculating the resistance of a fluid, namely :— Force = area × density × velocity squared ; and of mechanics, that a machine can never diminish the total expenditure of power necessary to overcome any resistance, and the great desiderata of naval architecture.

$$V^2 \text{ miles} = \frac{\frac{2}{3} \text{ Ind. H. P.} \times 100}{\text{Mid. Sec.}}$$

$$\text{Mid. Sec.} = \frac{\frac{2}{3} \text{ Ind. H. P.} \times 100}{V^2 \text{ miles.}}$$

$$\frac{2}{3} \text{ Ind. H. P.} = \frac{\text{Mid. Sec.} \times V^2 \text{ miles}}{100}$$

* From the Lond. Artizan, April, 1857.

In basing calculations upon these formulæ, the expression Mid. Sec. is the greatest section to the line of motion, and the reason for adopting two-thirds of the Ind. H. P. is its effective value to the length of a statute mile, the truth of which will appear in its application to the tabulated list of screw steamers. Now if any form presents less resistance than another, here is a common standard to exhibit its excellence for velocity, and the best means of testing the relative efficiency of the screw propeller and paddle-wheel when applied to vessels of any form, tonnage, and steam power.

In the following table the vessels are tabulated according to the degrees of efficiency for speed above or below the rate deduced from the formula, commencing with the highest; it will be observed that out of the twenty-nine vessels, sixteen are within 10 per cent. of the velocity given by the above formula.

Name.	Displacement to one No. H. P.	Mid. Sec.	Ind. H. P.	Actual Speed.	Speed per Formula.	Ratio of Speeds.	Pitch to Diameter.	Revolutions per Minute.	Engineers.
Plumper,	9	204	148	8·47	7·00	1·21	·62	115	Miller.
Reynard,	10	184	165	9·43	7·74	1·21	·91	108	Rennie.
Archer,	6	372	345	8·93	7·87	1·13	·86	108	Miller.
Arrogant,	7	580	623	9·48	8·40	1·12	·96	55	Penn.
Rattler,	5	274	428	11·5	10·20	1·12	1·10	104	Maudslay.
Rifleman, dimin.	5	175	188	9·15	8·48	1·08	1·12	110	Miller.
Niger,	3	403	828	11·70	10·84	1·08	1·36	68	Maudslay.
L'Alma,	6	509	1263	13·7	12·85	1·06	1·33	57	Humphrys.
Candia,	5·5	532	1356	13·7	13·04	1·05	1·28	66	Rennie.
Ava,	—	372	960	13·83	13·12	1·05	—	—	Todd.
Aden,	5	392	900	14·6	14·07	1·03	—	—	Summer.
Vulcan,	5	465	793	10·97	10·68	1·02	1·18	66	Rennie.
Minx, diminished,	20	82	32	5·15	5·09	1·01	·73	140	Seaward.
Encounter,	3	318	672	11·83	11·72	1·01	1·25	78	Penn.
Sharpshooter,	2·5	192	365	11·17	11·27	·99	1·12	140	Miller.
Himalaya,	4·5	560	2050	15·85	15·75	·100	1·55	59	Penn.
Ajax,	7	807	846	8·168	8·36	·97	1·12	48	Maudslay.
Dauntless,	4	522	1218	11·76	12·45	·94	1·22	68	Napier.
Phœnix,	5	347	382	8·11	8·54	·94	1·05	68	Penn.
Conflict,	3·5	402	777	10·616	11·31	·93	1·22	68	Seaward.
Amphion,	6·5	546	592	7·71	8·48	·90	1·4	45	Miller.
Fairy,	1½	72	364	15·227	17·2	·88	1·5	258	Penn.
Termagant,	4	587	1351	10·46	12·37	·84	1·16	66	Seaward.
Blenheim,	6	738	938	6·646	8·00	·83	1·25	43	Seaward.
Rifleman,	2	173	342	9·24	11·58	·80	1·12	119	Miller.
Teazer, diminished	5	83	128	8·77	10·15	·86	1·40	192	Penn.
Minx,	2	82	234	10·43	13·79	·75	1·11	254	Miller.
Dwarf,	1·1	66	216	12·04	14·76	·89	1·41	182	Rennie.
Teazer,	2	83	175	7·2	11 83	·63	1·29	200	Miller.

Before making the necessary conclusions upon the value of the proposed formula, it will be necessary to test a few of these examples, on the principle that the resistance varies as the cube of the velocity; the formula would stand thus

$$V^3 = \frac{\frac{2}{3} \text{ Ind. H. P.} \times 1000}{\text{Mid. Sec.}}.$$

Name.	Actual Speed.	Speed by V^3 Formula.	Speed by V^2 Formula.
Minx, diminished,	5·15	6·34	5·09
Himalaya, - -	15·85	13·46	15·75
Archer, - - -	8·93	8·51	7·87
Dauntless, - -	11·76	11·58	12·45
Vulcan, - - -	10·97	10·42	10·68
Fairy, - - -	15·22	15·00	17·20
Plumper, - -	8·47	7·88	7·00

However adverse these examples may be to the resistance varying as the square of the velocity, they prove incontestibly the value of the midship section theory for calculating the velocity of steam vessels. It is only by the greatest extremes—the *Minx* and *Himalaya*—that the truth will be elucidated, because the formulæ are based on the fact that 1 effective H. P. is required for one square foot of midship section to produce a velocity of 10 miles per hour; consequently, it is at this velocity which so many vessels approximate to, that has led to the adoption of the cube theory as the measure of the resistances. The following computation of the amount of H. P. for 100 sq. ft. of midship section for every mile will best illustrate the two principles:—

H. P. for V^3.	H. P. for V^2.	Mid. Sec.	Rate, Miles.
·1	1	100	1
·8	4	100	2
2·7	9	100	3
6·4	16	100	4
12·5	25	100	5
21·6	36	100	6
34·3	49	100	7
51·2	64	100	8
72·9	81	100	9
100·0	100	100	10
133·1	121	100	11
172·8	144	100	12
219·7	169	100	13
274·4	196	100	14
337·5	225	100	15
409·6	256	100	16
491 3	289	100	17
583·2	324	100	18
685 9	361	100	19
800·0	400	100	20

It is now necessary to point out that the midship section given in the data, more especially in screw steamers, is not the greatest section to the line of motion; that at the higher velocities (say 13 miles), the normal immersion of the after end of the vessel increases in a rapid proportion,

still further increasing the section to the line of motion, on which the calculations for velocity are made; that a variation from the rule may arise from the imperfections of the engine—the form of the propeller—the after end of the vessel, and more especially from the propeller not being properly immersed; these well known causes are a sufficient explanation for the deviation.

To proceed with the arguments, the *Minx* and *Himalaya*, as the two extremes, are proof that the square theory is correct, the Ind. H. P. in both vessels to Nominal H. P. being nearly 3 to 1.

The *Archer*, a fine pitch screw, well immersed, and the Ind. H. P. to Nominal H. P. being only $1\frac{1}{2}$ to 1 is a sufficient explanation for the deviation from the rule.

The *Dauntless* and *Vulcan* require no comment.

The *Fairy* now demands an explanation :—

1st. The Ind. H. P. to Nominal H. P. is nearly 3 to 1, the diameter of the screw 5 ft. 4 ins., mean draft of water, 4 ft. 10 ins., therefore not immersed.

2d. The ratio of the diameter to pitch 1·5. Now, as the coarse pitched screws are all on the negative side of the formulæ, a deviation from the rule may arise from that source. [Query, would not the angle from the axis of the screw be a better expression for the pitch ?]

3d. As a screw vessel, with only 168 tons displacement and 128 Nominal H. P., the vessel would be considerably by the stern, possibly 18 ins., which again would be considerably increased by the normal immersion of the after end of the vessel at 15·22 miles per hour, consequently the greatest section to the line of motion might be safely estimated at 93 (the midship section given 72 sq. ft.), the rate by the formula for the 93 ft. section would be 16 miles per hour, and for the cube formula 13·77 miles per hour, which, taken in connexion with the other mentioned reasons for deviation, proving the square theory correct.

Lastly, the *Plumper* is a beautiful illustration of the best conditions required in the screw as a propeller : in fact these arguments may be applied as the reason of the deviation from the rule in the whole of the twenty-nine tabulated screw steamers.

As an additional proof of the square theory being correct, an extract from the Report of the Trials of the *Charlemagne* (the usual system in the French Navy, which, if introduced into this country, would soon reduce naval architecture to an exact science), shall now be produced. With two boilers 3064 lbs., three boilers 2659 lbs. of coal was required to propel the vessel 8 miles per hour ; with four boilers, 5733 lbs. per hour propelled the vessel 10·9 miles per hour ; therefore,

lbs. of Coal.						Actual.
8^2	:	3064	::	$10{\cdot}9^2$	: 5688 .	5733
8^2	:	2659	::	$10{\cdot}9^2$	: 4936 .	5733
		or				
8^3	:	3064	::	$10{\cdot}9^3$	: 7749 .	5733
8^3	:	2659	::	$10{\cdot}9^3$	: 6744 .	5733

At the 8 miles the mid. section was 958·54, and at the 10·9 miles 953·19 sq. ft. : so that the necessary conditions for a comparison are

nearly equal, consequently again proving the square theory correct and the cube theory false, and economy in the consumption of coal by increased boiler space at the rate of 4 tons per day.

In sea-going steamships 5 lbs. of coal taken as the consumption of one effective H. P. will be found most valuable for every required calculation for velocity.

To return to the tabulated list of screw steamers, the following most important conclusions are confirmed:—

1st. That in the separation of the performances of the machinery from the question of the form in calculations of velocity, the duty of naval architecture is merely to provide the requisite displacement that the vessel may float at the agreed upon immersed midship section, the stability, strength, and other properties required in a vessel; all considerations for velocity being the province of the engineer.

2d. That the rate of sailing between two vessels with an equal moving power in each does not depend on the form of water-line, but entirely on the area of the greatest section to the line of motion.

3d. That displacement in the line of direction does not materially add to the resistance.

4th. And (what is the most surprising) that the friction between the sides of the vessel and the water need not enter into any calculation for any required velocity.

The first axiom is proved by the whole list of vessels. The second is triumphantly established by the same formula producing the velocity of the *Ajax* and *Himalaya*, two vessels of the most opposite type: in fact, it is completely established by every vessel produced in the list. The third and fourth by the longest and largest vessels, being at or on the positive side of the speed deduced by the formula, the exception being the *Amphion*, *Termagant*, and *Blenheim*, the former vessel can be safely attributed to the propeller, the two latter most decidedly to the engines; in fact, Seaward's engines are all on the negative side of the speed deduced by the formula.

It only remains for me to assert that the requisite conditions are not fulfilled, "for the maintenance of higher speeds than are attained by steamships in deep sea navigation."

In the application of these principles for the attaiment of higher velocities, and to render ocean steam navigation remunerative without Government assistance, *length* is the only alternative; and, as an illustration of its advantages, the *Himalaya* shall be taken as a basis for the necessary calculation, and the length of the voyage, 3240 miles—Liverpool to New York.

Length,	340 feet.
Breadth,	46 "
Mid. section,	560 sq. ft.
Displacement.	3220 tons.
Nominal H. P.,	700
Consumption of Coal,	80 tons per day.

The fact that the velocity by the formula was maintained between the *Fairy* and *Himalaya*, although nearly of three times the length, twenty times the displacement with only five and a half times the power; prov-

ing conclusively the 200 feet additional length (doubling the displacement), the same velocity would be maintained; therefore space for 2000 tons of cargo would be obtained; an ample remuneration for the additional size of the vessel; but if velocity was the object by doubling the nominal H. P., a speed of 22 miles per hour would be obtained with only an increase in the consumption of coal of 300 tons, still leaving space for 1000 tons of cargo with the same immersed midship section; it may be asserted that the velocity assigned to the *Himalaya* was only obtained at the trial of a single mile; but, by increased boiler space, say 50 per cent., that velocity could be maintained for the length of the voyage.

Then, again, by lengthening the vessel in midships an additional 200 feet, the displacement would be increased three times, and with three times the power, which would only maintain the original proportions of power to displacement, a velocity of 27 miles per hour would be obtained, or Liverpool to New York in five days. The dimensions then would be—

Length,	740 feet.
Breadth,	46 "
Mean draft of water,	16¾ "
Midship section,	560 sq. ft.
Displacement,	9660 tons.
Nominal H. P.,	2100
Consumption of coal,	240 tons per day.

With these proportions of the vessel we have only arrived at the same ratio of dimensions of the *New World*, one of the most modern vessels of the American rivers, the square root of the immersed midship section to length being as one to 27; in the lengthened *Himalaya* 1 to 31. Assuming the velocity of the *New World* at 20 miles per hour, and the immersed midship section (normal immersion of the after-end included) 210 sq. ft., the Ind. H. P. by the square formula $\frac{2}{3}$ Ind. H. P. $= \frac{\text{Mid. Sec.} \times V^2}{100}$ would be 1260, and by the cube formula

$$\tfrac{2}{3} \text{ Ind. H. P.} = \frac{\text{Mid. Sec.} \times V^3}{1000} \text{ 2520 Ind. H. P.}$$

As engineers, I ask, is it possible for one cylinder of the cubic contents (of a double stroke), 1203 cubic ft., to develop 2520 Ind. H. P., while one cylinder of the *Atrato* cubic contents for a double stroke, 903 feet, with the same number of revolutions, only developed 1635 Ind. H. P. at a trial at the measured mile, while the former is calculated for continuous steaming?

Again, assuming the consumption of coal at 3 tons per hour (about the same as the *Himalaya*), with the contrivances for increasing the combustion, 6 lbs. of coal is a very moderate calculation for 1 effective H. P.; consequently, the amount of that power would be 1120, which approximates nearer to the square than the cube theory.

N. B.—It is the want of reliable data that compels me to use this form of argument.

These assumptions, which are based on the highest degrees of pro-

bability completely proving that the asserted high velocities of the American steamers are only based upon the unerring laws of mechanics and hydrostatics, I can now, with the greatest confidence, challenge the naval architects of this country to bring forward their data to prove the slightest claim to any increase of speed by their nostrums, or to point out where great speed is obtained that it is not always on the side of the small midship section and increased steam power above the ordinary proportion of other steamships; by so doing, they will remove the imputation of having practised the most arrant quackery and the greatest imposition upon that age that boasts of the electric telegraph, the railway, and the mighty improvements in every other mechanical art.

It will now become the duty of the engineers of this country to assert their right to all credit for every fraction of the increase in the velocity of steamships—to assert their independence of the naval architect in all questions of velocity—to assert that the increased effective power of their engines have been completely neutralized by the theory of the sharp water-line, to assist me with all data (Mid. Sec. Ind. H. P. and consumption of coal) to combat that delusion so as to enable me to perfect the "Arithmetic of Naval Architecture" (published in *The Artizan*), which triumphantly illustrates the increased effective power of the more modern engines; it exhibits a system by which the economy of the engines can be calculated, and their claim to be considered the producers of that velocity unjustly claimed by the Naval Architect.

To the steamship owner, the advantages of bringing the science of naval architecture within the range of arithmetical calculation is of the most paramount importance. The facts elicited in the tabulated list of screw steamships point conclusively to the desiderata by which ocean steam navigation, at high velocities, may be made remunerative without Government assistance. As examples, take the *Dauntless* and *Dwarf*, the velocity of each is 12 miles per hour; in the former the displacement to Nominal H.P. is as 4 to 1, while in the latter it is as 1·1 to 1.

In the—

Archer,	6 tons to 1	Nom.	H. P.
Arrogant,	7	"	"
Minx,	20	"	"
Fairy,	1¼	"	"
Niger,	3½	"	"
Plumper,	9	"	"
Reynard,	10	"	"
Teazer,	2	"	"
Rattler,	5	"	"
Rifleman,	5	"	"
Himalaya,	4½	"	"
Vulcan,	6	"	"

Here is the fact, substantiated by data, that has the authority of the Admiralty for its correctness, that the four vessels that have the largest ratio between the displacement and nominal H. P. are the most efficient for speed; proving conclusively that the Midship Section and not weight, is the sole basis for calculations of velocity.

As another illustration, the ratio of the displacement to the immersed Midship Section shall be given in the following vessels, viz:—

Fairy,	2¼ tons to 1 sq. ft.
Minx,	2½ "
Dwarf,	2¼ "
Teazer,	2½ "
Arrogant,	4 "
Dauntless,	4 "
Aden,	4 "
L'Alma,	5 "
Candia,	5 "
Himalaya,	6 "

Here, again, is the fact that the vessels with the largest displacement to the midship section is a positive advantage to velocity, and the proof that displacement or surface in the line of direction does not increase the resistance or friction.

Let me illustrate these facts by the most powerful of arguments, £. s. d. By the *Himalaya* lengthened in midships until the displacement to nominal H. P. is the same as the *Reynard*, 10 to 1, these illustrations prove conclusively that 3000 tons of dead weight, with a clean bottom, could be carried from Liverpool to New York at the same expense of engine and coals, as at present, which, taken for the vovage out and home again, exclusive of passengers, would produce, at £3 per ton, £18,000, or, for nine voyages per year, £162,000, a sum amply sufficient, without assistance from any government, to remunerate the outlay for the increased tonnage of the vessel.

But the best proof that these views are correct will be established by what will be termed in after ages the greatest monument of the most stupendous delusion ever imposed upon this most practical age. The *Great Eastern*, with every confidence in the correctness of these formulæ for every requirement that I venture to predict, that this vessel—displacement to nominal H. P., 7 to 1; displacement to midship section, 11 to 1 (nearly twice that of the *Himalaya*,) and at an immersed midship section of 1600 sq. ft.—will be propelled at the rate of 18 miles per hour, provided the engines work up to the same proportionate indicated H. P. as the *Himalaya*. Can the most far-seeing imagine the immense results to be obtained by the complete establishment of the fact that 10 tons can be propelled by increased length at the same cost and rate as the 4½ tons in the *Himalaya*?

Such are the advantages to be gained by increased length, but, with the present system in the construction of vessels, we are at its limits; but are these profitable results to British enterprise to be lost, with such an example as the Britannia Tubular Bridge, asserting that vessels twice or three times the length of the present dimensions can be constructed of sufficient strength to sustain their weight in whatever situation they may be placed in? Even now it is possible to point out numerous vessels building exactly on the same principle which has been found to want strengthening after two or three voyages.

Again, it is easy to point out vessels that retain the same sectional form, ends, and water-lines, as the *Ripon*, *Indus*, *Pottinger*, and *Haddington*, that wanted the elements of stability; that in deviating from their course, at least 15 per cent. of their power was consumed by not sailing in a direct course; and it can safely be asserted that the means used to remedy that deviation were insufficient for the purpose—in fact,

the whole practice of naval architecture, both in the construction and formation of vessels, is a disgrace to the nineteenth century, and demands an immediate reconstruction.

To the capitalist the building of vessels by the facts here established will become the most profitable investment of capital of the day; it is the only mechanical art that remains for the application of machinery, the division of labor, and other appliances (detailed in "The Causes and Remedy of the Unprofitable State of Shipbuilding") that has increased the manufacture of this country to its present enormous extent; by the fact that the midship section is the sole basis for calculations of velocity. The best form of water-line can soon be decided. The stability and the other requisite conditions in the form of vessels can be established by the experiments of Attwood and other celebrities, whose experience has been lost to the present generation. Therefore, with a form of vessel (length in midships being the only improvement) firmly established, the application of machinery to each part of a vessel can be most profitably employed, without the risk of that continual change in the form of vessels that has existed during the last twenty-five years, which is only another proof of the absence of any established principles in naval architecture.

In conclusion, to every one interested in our naval and mercantile supremacy, and the progress of civilization, this subject is deserving of the most serious consideration. Let me point to the great progress in steam navigation during the last twenty years. Now, if that progress has been made upon a false theory, how much more rapid will the advance be when based upon a true principle? The present progress will dwindle into comparative insignificance when compared with the mighty results depending upon the establishment of the fact, that 10 tons, or even 20 tons, can be carried with the same amount of engine power as 1 ton. The only question remaining to be solved, is to what extent can the displacement in the line of direction be carried without affecting the speed deduced by the formula? With Australia reached in twenty-five days, New York in six, and the last remnant of protection (subsidies to steamship companies) proved to have been the greatest curse to the advancement of steam transport economy, in leading to the belief that high velocities were not possible to be remunerative without that assistance; when these are accomplished facts, then, indeed, we may boast of the progress of naval architecture.

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*On the Varieties of Permanent Way, practically in use on Railways.** By W. Bridges Adams.

[Read at a Meeting of the Institution of Civil Engineers, Feb. 3d, 1857.]

The Paper commenced by stating, that the calculations of Engineers, as to the strength and duration of "permanent way," had been baffled by the unforeseen increase of traffic, and that the proportions of the road to the heavy engines required to be reconsidered. It then described the principles involved—lateral and vertical strength of rails and firm joints,

* From the Lond. Civ. Eng. and Arch's. Jour., March, 1857.

—ample bearing surface of the rails on the sleepers, and of the sleepers on the ballast,—chemical durability of the materials,—the porous ballast for drainage,—and the buoyant principle for boggy ground.

The importance of the depth of the rail, to prevent too great flexure under the rolling load, was then dwelt on, combined with the principle of supporting the rail, by the upper portion, as closely as possible to the surface, to prevent displacement.

The chronological sequence of the various forms of rails, was the single T, the double T, the bridge, and the contractor's rail; then the chair serving as an extended base to keep the rail from tilting sideways.

The process of fish-jointing was then considered, with regard to its effect in converting each rail into "a beam fixed at the two ends," and thus practically adding to the vertical strength. It was shown, that the strongest form of the double-headed rail, in which the shoulders formed an obtuse angle with the vertical web, was the worst form for fishing, and that the fishes were only kept tight by an intense strain on the bolts, which commonly worked loose, so that if neglected, the suspended fish joint was less perfect than an ordinary joint chair. The practice of rolling rails with squared side channels, to get better hold on the rails, was a great evil, for the edges were thus exposed to be sheared off by the action of the engine wheels. A remedy for this was shown to be practically, by stamping the ends of the rails, whilst hot, in dies, so as to square the channels to the length of the fishes, and thus to compress the metal in the heads, and to prove its quality at that part where it was usually the least sound. Thus the seats for the fishes would be square indents and fac-similes. An improvement in the form of the fish itself was to roll it as an angle iron, with a horizontal rib below, which, while adding to the horizontal strength, afforded the means of securing a lighter class of bolts from getting loose, by keying them between the rails and the beveled sides of the nuts and bolt heads. A mode of keying ordinary fish bolts was also shown, by driving thin plate wedges between the beveled edges of adjoining bolts. A description followed of various other joints: Mr. Fowler's three wedge chair: Mr. Samuel's fish chair: Mr. P. W. Barlow's double chair, bolted below the rail; Mr. M'Conochie's wedge chair; Mr. Mansel's wood pile chair; Mr. Adams' bracket, or knee joint and intermediate fastenings used on the Great Northern and South Western lines, applicable equally to the double headed, and to the foot or contractor's rail; Mr. W. H. Barlow's double wedge key chairs; Mr. Parsons' fish key and wood lined joint chair; Mr. Burleigh's joint chair and long key, without wood lining; Mr. Wright's vice-joint chair; and Mr. Barningham's long double chair on two sleepers. Split rails, in two parts, breaking joint longitudinally, were then described, and also a system of wooden chairs and struts used in France.

The fishing and jointing of foot and bridge rails were then treated seriatim, and the truss joint for bridge rails, concluding the series, was described. Then followed the series of iron sleeper way,—Mr. Reynold's "hog trough metals," Mr. Greaves' spheroidal sleepers, Mr. P. W. Barlow's cast iron way, Mr. Samuel's wood lined cast iron sleepers, and Mr. De Bergue's cast iron sleepers.

Wrought iron way and sleepers, without timber, were then examined, beginning with Mr. G. W. Buck, in 1845, who produced a plan very similar to that introduced by Mr. W. H. Barlow, in 1849, the various sections of which were criticised. Then followed the girder rail, first propounded by Mr. Adams, in 1851, and now modified and successfully tested and extending in use. A sample of this rail 7 inches in vertical depth was shown, with angle brackets spreading to a width of 13 inches, breaking joints, and bolted beneath the horizontal webs. Plans of the same kind were also exhibited, applicable to the ordinary double T rail; a rail of 65 lbs. and a bracket of 28 lbs., with bolts bearing on shoes or on external edges, the bearing surface on the ballast being equal to a cross sleeper road with the sleepers at intervals of 3 feet. These wrought iron girder rails were, practically, beams; but were sufficiently elastic to prevent destruction by blows—a quality always insisted on by Mr. Robert Stephenson. Experimental results were given; and a description of Mr. Spencer's corrugated permanent way, completed the series.

Sixteen diagrams of varieties of permanent way, beginning with the stone-block system and ending with the girder rail, were exhibited, showing the various heights above the bearing surface on the ballast, from 18 inches down to 2½ inches.

Specimens were shown of Mr. Adams' double-headed girder rail, as used on the Great Northern Railway; of the bridge and truss joint, as used on the Great Northern and Western of Ireland, the Belfast and Ballymena, The South Coast, The South Western, and other railways; the bracket joint, as used on the Great Northern and South Western; and models of the bracket joint and intermediate brackets with two bolts; and of the mode of keying fish bolts.

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On some Recent Improvements in the Permanent Way of Railways. Read at the same Meeting. By P. M. Parsons, Assoc. Inst. C. E.

The improvements described in this Paper had reference particularly to the form of the chair, and to the nature of the fastenings. As laid on the East Kent Railway, the joint chairs weighed about 54 lbs. each, and with the exception of being somewhat longer, were in general appearance similar to ordinary chairs. They were 12 inches in length, and the sole or bottom, was provided at the underside with a cross rib at each end, overhanging the sleeper on each side, and forming with it an inverted trough girder, of which the ribs were the webs, and the sole or bottom of the chair was the flanch. One jaw of the chair was made to fit the shoulders of the rails, and the other was provided with two recesses, which received two thin creosoted elm blocks, cut across the grain, acting as cushions,—a wrought iron wedge, provided with jags, or barbs, being driven between the rails and the wooden cushions. In the intermediate chairs, one jaw was of such a form that the upper part pressed against the web, and the lower part against the side of the table. The other jaw had an inward inclination of about one in three, and was provided with a dove-tail recess, to hold the wooden cushion,—a cast iron wedge being introduced between it and the rail. This wedge, instead of fitting against both shoulders of the rail, was made to bear against the web and the upper part of its lower shoulder, by which the rail was forced down upon the seat, and was held firmly in a lateral direction.

A short length of way on this system was laid in 1854, on the Great Northern Railway, under the direction of the Engineer in Chief, Mr. Cubitt, and the results were considered to be very satisfactory.

Specimens of these chairs and fastenings were exhibited, and the subject was generally fully illustrated by a large series of models furnished by the Permanent Way Company.

Discussion upon the "Permanent Way of Railways," at the meetings of Feb. 10 and 17. It was remarked that the Paper omitted all notice of the class of fastenings employed previous to the introduction of the wooden key. This class consisted either of iron pins, small iron wedges, or screw bolts, all embodying the same principle of small metal surfaces bearing upon small points of contact. The fit was generally very imperfect, and the fastenings rapidly deteriorated. When, from any irregularity of fit, an undue strain came upon the bolt, the thread of the screw was stripped, or the nut took a particular set, to which it always returned when screwed up. These fastenings were abandoned simultaneously by all Engineers in favor of the wooden key, which presented an elastic medium to compensate for inaccuracies, and brought comparatively large surfaces into contact.

A recent examination of some brackets and fish plates, which had been laid down about twelve months, and were secured by bolts and nuts, showed that in 125 pairs of joints, each pair having 8 bolts, 261 bolts were loose, and 6 were out altogether, though they had been tightened up within 48 hours. The number of loose bolts at each joint varied from 1 to 8. It was contended, therefore, that bolts and nuts, such as were originally used, were unsafe, inefficient, and expensive fastenings, for connecting together the parts of a permanent way, and that they were not to be relied on.

It was argued that a simpler system for binding the different parts together, was to employ wedges, which were always capable of performing their office, and were tightened up by a blow of a hammer.

With regard to the "girder" rail, it was contended, that experience had proved its rigidity and want of elasticity to be so great, that the heavy weights now carried on railways would soon destroy its upper surface, and cause it to laminate. The effect, too, of reducing the thickness of the middle web, would be to increase the cost of the rails per ton—and though credit had been taken for a saving in the item of ballast on this system, it was thought that Engineers generally would not like to diminish the amount of ballast on a railway.

It was observed, that an essential principle in a permanent way, was to form the various lengths of rails into continuous bars, by fixing them firmly at their ends, either by chairs, or brackets, or fishes, (keyed, or bolted,) or by break-joint angle plates. With a view to prevent the bolts from getting loose, a system had been devised for locking both heads and nuts, so as to prevent them from turning round. This was proposed to be accomplished by beveling the edges of the bolts and nuts where in contact with the fishes, so as to form grooves in which to drive plate wedges between contiguous bolts, and then to fix them by turning up the corners. It was mentioned that the original "fish" was

keyed into the chairs and not bolted ; and it was believed that this was firmer than the subsequent modification of the "fish-joint" with bolts, suspended between chairs. To compress the ends of the rails, and at the same time to form square channels for the fishes to lie at rest, without strain on the bolts, it was proposed to squeeze the ends of the rails whilst hot, between a pair of dies.

With reference to the comparative weights of the cast iron sleepers used on the Londonderry and Enniskillen and the South Eastern Lines, it was stated that the lightest portion of the latter was 5 per cent. heavier than the heaviest portion of the Enniskillen permanent way, whilst the general average was 18 per cent. heavier. Altogether about 225 miles of these cast iron sleepers had been laid on different railways in England and Ireland during the last five years, and only about 1 per cent. per annum had required to be replaced from all causes. Experiments had recently been made to test the strength of different forms of cast iron sleepers, for which purpose a falling ram, weighing 12 cwt., was employed. Twenty-three forms were experimented upon, and the result was that an ordinary 80 lb. rail, with 3 feet bearings, was destroyed, by bending, with a fall of 2 feet, whilst the South Eastern sleeper bore a fall of 4 ft. 6 ins., being 1 foot more than any other which was tried.

A trial of a short length of De Bergue's cast iron sleeper way on the Great Northern Railway, was stated to have shown that the plate sleepers required a less amount of attention as to packing and lifting, than the ordinary transverse wood sleepers. The chief defect of this system was asserted to be the method of fixing the rail to the sleepers. It might possess some advantages of cost in some situations, and with some modifications would probably be made to answer well for light traffic. Adams' suspended girded rail had also been subject to a similar trial, and the result was, in some respects, very satisfactory. It was nearly equally rigid in all its parts, possessed a certain amount of elasticity derived from the wings, and but little vertical deflection. It presented great facilities for packing, and could be lifted in less than half the time required by the wood sleeper system. It might be advantageous for the future to increase the width of the tread of the rail.

It was stated, that there were now about 800 miles of single line laid with the Barlow rail, and that though in the first instance transverse wooden sleepers had been used, yet this method had now been abandoned, the rail being laid down without sleepers. The difficulties were the manufacture of a sound rail, and the rigidity of the way when made. The wrought iron way was more rigid than that of the cast iron. The rigidity of the latter might be overcome, it was believed, by the adoption of Samuel's trough sleeper with wooden fastenings. It was remarked that there were now more than 1000 miles of single line of iron permanent way laid and in operation. The practicability of the use of that material had, therefore, been proved, though, probably, the best form might not yet have been devised. It was considered singular that a country abounding in iron should annually expend hundreds of thousands of pounds in bringing timber from foreign countries, to lay and rot on the railways of the kingdom.

It was stated that a recent examination of some portions of the South

Western Railway, demonstrated the solidity of the permanent way laid with fish joints; very few, if any, of the bolts and nuts were loose, and the line generally was in a very good state. The same might be said of Samuel's fish chairs, and of Greaves' system, which had been so extensively and satisfactorily used on the Egyptian railways. Where bad bolts and nuts had been used they were loose and had caused much trouble, but if the company would permit a due expenditure, it was not at all difficult to make such a way as would be really permanent; indeed, as was subsequently remarked, wherever good materials of sufficient weight and well put together, were employed, it was difficult to make a bad permanent way. Nothing but undue economy induced such a result. The compressed wooden keys were first tried on the Liverpool and Manchester Railway in 1835, and the improvements in their manufacture introduced by Messrs. Ransome and May, had materially extended their use. The double-headed rail was first rolled under the direction and from the designs of Mr. Locke, and it was asserted, in contradiction of some statements relative to their not being reversed, that there were few, if any, rails of that description finally rejected as being worn out before they had been reversed in the chairs. As to the assumed rigidity of cast iron permanent way, it was shown, that the specimens of Greaves' and of De Bergue's iron way, demonstrated the fallacy of such an assumption, as they were both found to be, after many years hard usage, in an excellent state of preservation, and had not produced any injurious effects on the rolling stock.

It was admitted, that in many of the experiments on fishing joints, indifferent materials had been used and with corresponding results; they had been first adapted to railways in a bad condition, where the ends of the rails were injured, and the fishes did not fit; the pins were thus broken and the results were disastrous; but when they had been adapted to new or uninjured rails, the results were invariably good.

It was objected to the Paper, that it had overlooked many of the most salient improvements, such as the bridge rail, and Ransom's and May's cast iron chairs, which latter were, with the compressed keys and trenails, now used on nearly six thousand miles of single line of permanent way. Also, that the Barlow rails did not, as had been asserted, suck up the water beneath them; but that the ballast, when duly packed, was solid and remained for a long period without failing.

The compressed wood trenails and keys, with cast iron chairs of uniform construction and good form, and a rail not exceeding 82 lbs. per yard, fixed at the joints, made a very firm and good way.

It was asserted with respect to the fish joint, that Mr. Richardson was the real inventor,* he being at the time an assistant engineer on the Eastern Union Railway, where the fishes were first used by Mr. Bruff to tie together and stiffen the ends of the rails, and render them, in fact, a girder across a weak bridge on that line. To this it was replied, that Mr. Richardson's first idea was not a fished joint at all, but merely a scarfed joint rail, which was not adopted, because it was not considered

* The "*fish joint*" as now used, appears to be an American invention. The inventor, R. H. Barr, of New Castle, Delaware, having made and deposited, in 1843, in the Franklin Institute of Philadelphia, a model of "*fish joints*" as now used.—Com. Pub.

effective. Mr. Adams then produced a joint having the same object as the operation of fishing a spar, an operation so well known to seamen: it was patented in the names of Adams and Richardson, the former gentleman drawing the specification and making the models at his works, where they were seen and approved of by Mr. Peter Ashcroft, before the period of the competition for the prize, offered by the Eastern Counties Railway Company, for an effectual method of securing the joints of rails. This was believed to be the correct version of the invention of the fished joint. It was at the same time stated, that upwards of twenty years ago, several hundred tons of these fishes had been rolled, and been exported from Liverpool, by Mr. Edwin Mawe, to* America and to Germany, and that there was not any novelty in their subsequent introduction on the English railways.

It was urged, that the method of depreciating all previous systems for the purpose of advocating a new introduction, was unwise. The Engineers would judge for themselves as to the merits of new inventions, and were much better able to judge of them than the inventors themselves. It was very prejudicial to the profession, that Engineers, having the control of railways, should become patentees, and band themselves together for the purchase of other inventions to be used on the lines upon which any of them were employed; it laid them open to suspicions to which professional men should not be subjected, and gave a color to the statements that contractors were obliged to pay for the use of these patents, in order to prevent their tenders from being rejected, on other occasions, when submitted to engineers so placed.

It had been attempted to be shown, that it was advantageous for a company to become possessed of a number of patents, in order to facilitate dealing with them; but it was contended, that when there were numerous inventors whose claims were nearly balanced, it was more probable, that engineers would be able to arrive at equitable and reasonable arrangements for the use of the inventions, on better terms for the railway companies.

It was stated, that the permanent way adopted for the lines of railway in the East Indies, was of the simplest character, consisting of the ordinary double-headed rail, laid with chairs on transverse wood sleepers, and connected with fished joints; explanations were also given of certain points in the design and construction that had been carefully attended to, in order to ensure a successful result.

The fallacy of asserting, that a flat country admitted of the use of smaller engines and lighter permanent way, was demonstrated. The precautions necessary for constructing railways in Norway, Denmark, Canada, and all countries where the cold was intense, were explained, and it was shown, that the engineer must adapt the system of permanent way to the circumstances of the country and climate.

It was admitted, that it was desirable to separate as much as possible, the commercial from the technical questions, avoiding the former, in discussions at the Institution, but it was difficult at all times to do so.

In addition to the systems previously mentioned, specimens and drawings were exhibited of cast iron chairs used on the East Lancashire

* These were merely "*link plates*" not regular "*fish plates*.—Com. Pub.

Railway, by Mr. J. S. Perring; of Spencer's corrugated sleeper road; of a new rail by Mr. Bagot; and of a solid chilled crossing by Messrs. Ransome and Biddle.

For the Journal of the Franklin Institute.

New Formula for Computing the number of Balls in the Triangular, Square, and Oblong Piles. By Horatio Hubbell.

Computation of the Triangular Pile.

To compute the number of balls in this pile,

Let n represent the number of balls in the base row of the lower tier, then:

$$\begin{aligned}
&n+(n-1)+(n-2)+(n-3)+(n-4)+\ldots(n-n)\ \text{1st tier.}\\
&(n-1)+(n-2)+(n-3)+(n-4)+\ldots(n-n)\ \text{2d tier.}\\
&(n-2)+(n-3)+(n-4)+\ldots(n-n)\ \text{3d tier.}\\
&(n-3)+(n-4)+\ldots(n-n)\ \text{4th tier.}\\
&(n-4)+\ldots(n-n)\ \text{5th tier.}\\
\text{Sum}\quad &\ldots(n-n)\ \text{6th tier.}\\
1\,n+2.(n-1)+3.(n-2)+4.(n-3)+5.(n-4)+\ldots&\ 0-0
\end{aligned}$$

Suppose $n=5$, then the foregoing sum becomes,

$1\cdot5+2\cdot4+3\cdot3+4\cdot2+5\cdot1$, or there are two series, one the reverse of the other—multiplied together—with their products added,

thus, $5+4+3+2+1$
Multiplied by $1+2+3+4+5$ member by member.

Products $5+8+9+8+5=35$.

This I denominate a *symmetrical series.*

In these symmetrical series—when the series begins with an odd figure, (as the above) the differences are the odd numbers inferior to the first term—and the mean term is single.

When the series begins with an even number as 6, the differences are its inferior even numbers, and the mean term is duplicate.

It is evident, that in these series, it is only necessary to calculate the first moiety, and then duplicate, to have the sum of the whole series.

The general expression for that purpose whether with an odd or even figure is,

$n+(n+n-2)+(n+n-2+n-4)\ldots+(n-n+1\text{or}2.$ } Ending 1 or 2 as the series begins with an odd or even figure.

This multiplied by 2 gives the whole series:

(6.) Taking care, however, when it begins with an odd figure, *not to duplicate the last term*, otherwise it *must be again subtracted.*

The usual formula for the triangular pile is,

$$\frac{n\,(n+1)\,(n+2)}{6}.$$

Let $n=5$, then $2\left((5+(5+3)\right)+(5+3+1)=2.(13)+9=35.$

Let $n=6$, then $2\times\Big[(6+6+4)+(6+4+2)\Big]=2\times[16+12]=56.$

The above general formula $n+(n+n-2)+(n+n-2+n-4)+$ &c., p being=number of terms,

may be thus summed, $n\left(\frac{p(p+1)}{2}\right)-2\Big[(1)+(1+2)+(1+2+3)\Big]$&c.

say there are four terms, $n\left(\frac{4\,(4+1)}{2}\right)-2\Big[(4)+(6)\Big]$

7 will run 4 terms as

$n+(n+n-2)+(n+n-2+n-4)+(n+n-2+n-4+n-6).$

Then let $n=7$ it is $7\times10-20=50$, which multiplied by $2=100$ minus the last term or $4\times7-(2+4+6)$ or $28-12$ or 16 from $100=84$sum.

Computation of the Square Pyramidal Pile.

Let n be the number of balls in the outer row of the lower tier; then $n^2=n^2$ 1st tier.

2d tier, $(n-1)^2=n^2-2\,n+1.$
3d tier, $(n-2)^2=n^2-4\,n+4.$
4th tier, $(n-3)^2=n^3-6\,n+9.$
5th tier, $(n-4)^2=n^2-8\,n+16.$
× × × × × × × × ×
$(n-n)^0=0$

Assume $n=5$ the squares of $(1+2+3+4+\ \ldots\ n)=$ whole number of balls or $(1+4+9+16+\ \ldots\ n^2)$ which are the last terms of the above expansion of the first squares.

The first and second terms of the said expansion neutralizing each other thus:—

$n^2=25$	$n^2=25$	$n^2=25$	$n^2=25$
$-2\,n=10$	$-8\,n=40$	$-4\,n=20$	$-6\,n=30$
$+15$	-15	$+\ 5$	$-\ 5$

The analysis of the above squares $1+4+9+16+\ldots n^2$ results thus:—

$$\left.\begin{array}{l}5\ n\\4\ (n-1)\\3\ (n-2)\\2\ (n-3)\\1\ (n-4)\end{array}\right\}\quad\text{or}\quad\begin{array}{l}5\,n\\4\,n-4\\3\,n-6\\2\,n-6\\1\,n-4\end{array}$$

The sum of which is making $n=5$,

$$5\left(\frac{5\times6}{2}\right)-2\,(4+6)=55.$$

And the general formula,

$$p \text{ being}=n-1 \text{ is } n\left(\frac{n\,(n+1)}{2}\right)-2\left[p+(p+p-2)\right].$$

or if $p=$an *odd number* it is :— $\left[2\,(p)+(p+p-2)\right]$. See (6) p. 20.

The usual formula by differences is,

$$\frac{n\,(n+1)\,(2\,n+1)}{6}.$$

Computation of the Oblong Pile.

To compute the number of balls in this pile,

Let $m=$the number of balls in the outer row of the bottom tier of the longest side.

Let $n=$ the number of balls in the outer row of the bottom tier of the shortest side.

Put $n=5$ and multiply as indicated.

Then $m\times n=$ 1st tier.	$5\,m.$
$(m-1)\times(n-1)=$ 2d tier.	$4\,m-4.$
$(m-2)\times(n-2)=$ 3d tier.	$3\,m-6.$
$(m-3)\times(n-3)=$ 4th tier.	$2\,m-6.$
$(m-4)\times(n-4)=$ 5th tier.	$1\,m-4.$
$\times\times\times$ $\times\times\times$ $\times\times\times$	$15\times m-20=$ when $m=9$ to $135-20=115$
$(m-m)\times(n-n)=000.$	or $9(1+2+3+4+5)-(4+6+6+4)=115$

Let $p=n-1$.

The general formula is,

$$m\left(\frac{n\,(n+1)}{2}\right)-2\,(p+p+p-2) \text{ a symmetrical series,}$$

$$\text{or in numbers } 9\left(\frac{5\,(5+1)}{2}\right)-2\,(4+4+2).$$

The subtractive part *a symmetrical series*, or

$15\times9-2\cdot10=115$ amount of balls in pile.

The usual formula by differences.

$$n\left(\frac{n+1}{2}\right)\left[\frac{m+2\,(m-1+n}{3}\right]$$

For the Journal of the Franklin Institute.

Practical Views on the Proposed Improvement of the Ohio River. By W. Milnor Roberts, Civil Engineer.

The Ohio River constitutes a part of the most extensive inland navigation known to the world; and if anything whatever in the interior can be so regarded, it is eminently national in its character. Eight States—New York, Pennsylvania, Virginia, Maryland, Ohio, Kentucky, Indiana, and Illinois, are watered by the Ohio and its tributaries; and eight more—Wisconsin, Iowa, Missouri, Tennessee, Arkansas, Alabama, Mississippi, and Lousianna, are directly connected in navigation interests, through the Missouri and Mississippi Rivers. To these may be added, the Territories of Minnesota, Nebraska and Kansas. Texas, also, on the Gulf of Mexico, is in very direct water communication with the navigation of the Ohio River. These States and Territories comprise within their limits even more than half the population of the Union; and since the introduction of the railroad system, working in harmony with these grand internal water communications, the commercial interests of all the States have become so interwoven that all are in reality interested in maintaining the navigation of this river.

The value of the commerce passing annually along the shores and miles of river between its head at Pittsburgh, and its mouth at Cairo, is enormous—not less than three hundred millions. And the business would annually increase much more rapidly but for the frequent and long continued interruptions caused by want of water in the channels. Hence, the preservation and improvement of this stream as an economical avenue for the interchange of a national commerce, has assumed a national importance.

The destruction or serious injury of a channel so advantageously placed, and forming a vital link of an almost boundless system, would therefore injuriously affect the commercial, manufacturing, and agricultural interests of the country. Such, indeed, has been the case to the extent of millions of dollars in more than one season, and especially in 1856.

Steam has given to our rivers an importance as commercial arteries which can scarcely be overrated, and the steamboat interest on our western waters now includes an aggregate capital of at least one hundred millions; over twenty millions of which are invested in steamboats alone. The interior steamboat interest is second only in amount to the railroad capital; the two combined, taking the entire Union, probably amount to one thousand millions of dollars.

Regarding our rivers and railroads, with their steamers, and locomotives, and cars, as the machinery for the mere *movement* of the trade and travel of the States, what must be the grand aggregate value of the things conveyed? Before the introduction of the steamboat, the trade on the Ohio River, and on all of the western waters, was quite small, and confined chiefly to descending craft which floated with the current. Had the same primitive mode of conducting business continued to this day, the increasing irregularities in the navigation would have attracted

little attention, because of the comparatively trifling interests concerned. But the country, through the instrumentality of steam, having become familiar with the real value of a great river navigation, and with its intimate and friendly relationship with the railroad system, now looks with anxious concern upon the melancholy fact which cannot be denied, that the river, instead of becoming better, is gradually becoming less and less reliable as a navigation. The cause of this failure appears to be almost by common consent ascribed to the gradual cleaning away of the timber from the head waters and along the main streams. It seems to operate in two ways: by lessening the annual downfall of rains and snows, and by augmenting the annual evaporation.

For months consecutively, and occasionally through almost an entire business season, no dependence can be placed upon the river as a channel of shipping, particularly by those living at a considerable distance therefrom, as there is a general apprehension that by the time goods may reach a given point, the water may have receded. This causes millions of dollars worth of property to lie idle for long periods as dead capital; restricts the manufacturing capabilities of the manufacturing cities, limits the agricultural productions, and of course decreases the commercial prosperity of the country. The evil has become so notorious—the public feeling so aroused to the necessity and expediency of attempting some radical remedy, that little doubt can be entertained that Congress during its ensuing session, will at least provide for the necessary preliminary surveys and investigations, or in such manner as will speedily determine the question as to the best plan for permanently improving the river.

Having conceded that Congress will probably pass a law authorizing the examination of the whole subject, the inquiry naturally arises, "why then discuss it in advance?" In answer, it may be said, that although there are some features the merits of which can only be finally settled from the results of actual surveys; there are others, important and interesting, which the engineers and practical men generally of this country, may investigate beforehand; the elaboration and determination of which are not dependent on future surveys: that there are elements enough already within reach, worthy of the attention and examination of the ablest minds of the land.

The question is not merely one of dollars and cents that may be involved in the adoption and completion of a particular plan; it is of the first consequence that that plan shall be one with which the sober good sense of the country will rest satisfied, and which, in the end, will be productive of the greatest benefit.

The engineering features are of sufficient magnitude to entitle them to the candid and thoughtful consideration of the entire profession; and a fair discussion of them should be encouraged and aided by our civil engineers. Several members of the profession have already taken part in it, and in their different papers and publications may be found many interesting views.

Much desultory writing, and various crude suggestions have been thrown off for a long period of years; and for several years, between 1837 and 1840, the government was actually engaged in improving the river by means of loose stone wing dams, but without much effect.

Locks and dams were suggested at an early day by Edward F. Gay, Esq., Civ. Eng., and others; and in 1839, after some experience on the Slackwater Improvement of the Monongahela River, the writer ventured to entertain and express the opinion that at some future period the Ohio River might be thus improved.

In 1849, Charles Ellet, Jr., Esq., Civ. Eng., wrote a paper on the subject of the "Physical Geography of the Mississippi Valley," published by the Smithsonian Institution, in which he promulgated and recommended his plan for the improvement of the Ohio and other western rivers, by means of *Artificial Reservoirs*, to be constructed on the navigable branches, or on the smaller tributaries. The water thus stored to be drawn out in dry seasons, to keep up the regular flow of the rivers. The same general ideas were reiterated, in a larger work "Upon the Mississippi Overflows," published by Lippincott, Grambo & Co., of Philadelphia, in 1853. In March, 1855, Josiah Copley, Esq., an intelligent gentleman of Pittsburgh, who had paid considerable attention to the subject of the improvement of the Ohio, prepared an article which was published by direction of the Board of Trade; and January 1st, 1856, another, both appearing in pamphlet form, under the auspices of the same Board. Mr. Copley has exerted himself not only in writing, but in various ways to point out and enforce the great necessity and importance of a radical improvement of the river.

In 1855, Herman Haupt, Esq., Civ. Eng., published a work in pamphlet form, entitled "a Consideration of the Plans for the Improvement of the Ohio River," in which, after reviewing the plan of "Locks and Dams," and the "Reservoir Plan," he proposed a third plan, to consist of a succession of open dams of 6 to 10 feet height, without locks; the pools to be connected by an open channel 200 feet wide; the channel to be formed by means of mounds or embankments extending lengthwise from the end of the dam far enough up each pool to equalize the flow. In fact, it would make a navigable canal 200 feet wide, with an average descent between Pittsburgh and Cairo of about 6 inches per mile.

In the Spring of 1856, Mr. Ellet condensed and arranged his views into a more popular shape, and published them in the *Cincinnati Gazette*. Soon after, at the request of a friend, an answer was prepared by the writer, which was published by the Board of Trade of Pittsburgh. This answer was not designed to be regarded as the argument on behalf of locks and dams; its main object being to correct what appeared to be erroneous in the published papers of Mr. Ellet. It was republished in January of this year, in the *American Railway Times*, Boston.

In January, 1857, Ellwood Morris, Esq., Civ. Eng., commenced the publication of a paper "On the Improvement of the Ohio River," in the *Journal of the Franklin Institute*, which was continued in February, and concluded in the March number. It has since been published in a separate pamphlet.

It is certainly true, that the writings of these three gentlemen, Messrs. Ellet, Haupt, and Morris, as literary productions, are highly creditable to the profession.

Previous to the publication of any of these papers, in 1838 and 1839, Major (then Captain) Sanders, of the Topographical Engineers, was engaged as Government Superintendent; first, in surveying the Ohio River, and then in planning and carrying into execution certain improvements (already alluded to,) partially by means of wing dams, and partially by cleaning out the channels. Even after the suspension of these operations, Major Sanders continued the advocate of that method of improving the navigation; although it is proper to state, in this connexion, that he promised only a two and a half feet stage in low water, without the aid of artificial reservoirs. Considerable money was expended, some good was accomplished, but the appropriations were discontinued, and the work ceased. A further reference to this plan will perhaps be made, incidentally, in the course of this paper.

Long anterior to this period, from 1824 to 1826, a private corporation styled the "Louisville and Portland Canal Company," had constructed a steamboat canal and locks around the Louisville Falls, under the direction of Canvass White, Esq.,* Civ. Eng. The locks were made of sufficient size to accommodate the steamers of that day; but the great increase in the dimensions of steamers afterwards led to much inconvenience. Many being too large to pass through the locks, could only "run the falls" during high water. Government became a purchasre of the stock of this company, and now controls the works. Extensive repairs were made to these works in 1856, at the expense of the general government, under the direction and superintendence of Edward Watts, Esq., Civ. Eng., who, at the instance of the War Department, has furnished plans and recommended an appropriation for their permanent enlargement on a magnificent scale. This is the most difficult and expensive point on the whole river.

From 1837 to 1840, the writer was engaged as Engineer of the Monongahela Navigation Company, in surveying that river, and planning and erecting the locks and dams forming the slackwater between Pittsburgh and Brownsville. He afterwards made a survey for the Ship Canal, at the Sault St. Marie, and aided for a number of years in urging that great work upon the public attention. But it should not be inferred that it is his design to make this paper a mere advocacy of any one plan for improving the Ohio River. On the contrary, it shall be his aim carefully to examine, and fairly present all the plans, for the further consideration of the public; holding this paper like those papers he shall consider, subject to criticism from any interested party.

It is proposed to consider the several plans in the following order:

1st. The *Reservoir Plan* as proposed by Mr. Ellet; chiefly as modified in detail by Mr. Morris.

2d. The *Low dam and chute plan* without locks, as proposed by Mr. Haupt, but chiefly with some modifications suggested by the writer.

3d. The "System of Locks and Dams," with sluice-ways or chutes for descending craft.

I. The Plan of Artificial Reservoirs.

It is stated, that the area of country drained by the Ohio River, its

* Some time since deceased.

confluents and tributaries, above the City of Wheeling, is 24,337 square miles. From a careful examination of good maps showing the sources of the streams, the writer believes that this is sufficiently accurate for all the purposes of this discussion.

Estimating the *available* average annual downfall of water in the region under consideration at 12 inches,* the whole number of cubic feet would be 678,476,620,800. So that if the whole were stored in reservoirs, it would afford a daily flow of 1,842,401,700 cubic feet; which according to the calculations made by Mr. Ellet, of the quantity passing at Wheeling at different stages of the river, would give a constant depth of *eight* feet. It is proper to mention, however, that during one year, as shown by the record kept (in 1845), the actual flow, according to Mr. Ellet's calculations, would have furnished a constant depth of but 7 feet over the bar at Wheeling. This proves from the calculations, that there has been a year when the available downfall was less than 12 inches. It was in fact but 9·83 inches, according to the calculations of Mr. Ellet and Mr. Morris.

But the record of the height of water at Wheeling, kept through a period of years, as elaborated by Mr. Ellet, having shown that more than enough water passed down, *even in the driest year*, if it had been equalized throughout the season, to have afforded a constant depth of more than six feet; and any reasonable calculation based on the extent of country drained, showing a like result, it leaves no room for controversy in regard to the first important proposition; and it must be granted that enough water *falls* every year, if it could be equalized, to give six feet depth constantly over the bar at Wheeling.

The object of the advocates of the artificial reservoir plan, being to secure a constant depth of six feet at Wheeling, we may next consider whether the data obtained from the daily record of the height of the river, taken in connexion with the measurements of the rate of flow, and the calculations based thereon, are sufficient to show, without further examination, how much water must necessarily be stored in reservoirs to accomplish this result through the driest year recorded. This second point has been but imperfectly investigated, and yet without further surveys, some additional light can be thrown upon it.

The driest season, 1845, would have yielded an average depth of but *seven* feet at Wheeling, from an available downfall of less than 10 ins.; and yet Mr. Morris assumes in his calculations, 18 inches as the reliable depth from the drainage of 3600 square miles; and also, that the drainage of this area is to be stopped and held by six dams, not exceeding 100 feet in height. Now, as works of this sort must be planned for extreme cases in order to be constantly useful, would it not be the part of prudence to take the dry seasons as the gauge? Similar seasons in future may be more frequent than they have been in the past. Founding our calculations on such a dry season, we ought not to assume much more than half of the depth allowed by Mr. Morris as available from the drainage; though other engineers as well as the writer, in reference to this very region, have heretofore estimated a depth of 12 inches, or two-

* The important practical question—how much water from drainage may annually be *relied upon* to be stored in artificial reservoirs draining given areas? will be considered in another place. (See Appendix A.)

thirds of Mr. Morris's quantity. Mr. Ellet says, "The discharge is therefore about 40 per cent. of the total fall, showing that 60 per cent. of all the rain and snow that come to the earth in this latitude is carried back to the clouds in vapor and never reaches the ocean," and that "the *average* annual fall of rain at the head of the Ohio is 36 inches." Now this necessarily implies, that in some years it must be *less* than 36 inches. The experience of the writer, in connexion with a reservoir on one of the tributaries of the Ohio above Wheeling, led to the conclusion that it is not safe in this latitude to count on saving or utilizing more than $33\frac{1}{3}$ per cent. of the annual downfall of rain and snow. A further investigation of this very point made some years ago by the writer at the instance of Major Walter Gwynn, Civ. Eng. of Virginia, confirmed this opinion. This being settled, it would, according to the other calculations of Mr. Morris, require *nine* instead of *six* large reservoirs of capacity sufficient to contain the drainage of 600 square miles each, and 5400 square miles in the aggregate. And of course, if his estimate of $12,000,000 for six reservoirs be correct, it will be equally correct to assume $18,000,000 for nine.

But the elements which belong to the moderately sized reservoirs, hitherto constructed in this and other countries, for the purpose of supplying canals or water-works, will not be found as component parts of the *immense artificial lakes* introduced into this question, as means for maintaining a steady flow in large navigable rivers. Where a reservoir is to be constructed large enough to hold the entire drainage of 600 sq. miles, (even allowing but 12 inches instead of 18 to be available,) there is little opportunity of choosing sites "near or upon elevated grounds, with moderately steep water-sheds of ordinarily impervious material;" because if you take sites near or upon such elevated grounds, you cannot command the drainage of enough territory to meet the other requirement—600 square miles. Again, Mr. Morris perhaps, without sufficient scrutiny of the calculations of Mr. Ellet respecting the quantity of water that a given height of dam will hold in check, has largely over-estimated the actual capacity of any such reservoirs. He proposes dams of 100 feet height, and assumes that they will afford over the whole superficial area overflowed, an average depth of half the greatest depth at the dam; whereas, it will be found, that this average depth will not be more than one-third to four-tenths of the greatest depth at the dam. It is practicable to build dams 100 feet high on the tributaries; but is it practicable to unite with them the requirements of 600 square miles of drainage, and the capacity of the reservoirs to contain the drainage, for nine such structures, or for six, or what number? In the case of a *small* reservoir, such as might yield a supply for the Ohio River for half a day, it is barely possible that a site could be secured where the average depth might be *nearly* half the greatest depth at the dam;* but for the *great reservoirs* now under consideration, the average of half the greatest depth can only apply to that portion of the reservoir which is directly above the natural *bed of the stream* itself. Whatever space is occupied by the bottom lands, and side hill slopes of the valley, must go to reduce the average depth.

* It could not be as much as *half*, except in a case where there was no valley save the river or creek itself; and where the sides were vertical. Such a site does not exist on any of the head-waters of the Allegheny River.

The surveys, if made, will probably show that *one-third* of the greatest depth is a liberal average to allow. This would reduce the *capacity* of the assumed reservoirs one-sixth.

Take an ordinary case of a stream 300 feet wide, falling 4 feet per mile, with bottom land on one side 500 feet wide, 25 feet above the stream, and side hill slopes of 4 feet base to 1 foot rise. Throw across a dam 100 feet high; the average depth even *at* the dam is but 65·8 feet, and half way up the pool, but 31·1 feet. Take another case similar to the above without any bottom land: the average depth at the dam will be 63·6 feet, and half way up the pool 35·7 feet. And where there are bottom lands of even moderate height, the upper miles of the reservoir would be confined within the narrow limits of the natural stream. In a vast majority of all the reservoirs which could be formed either on the main streams or on the tributaries under consideration, the actual shape of the whole prism of water will be found to approach the form of a *cone* more closely than that of the *wedge*. Hence it will not answer to assume one-half the greatest depth at the dam as the average depth of reservoirs.

Starting upon the data assumed by Mr. Morris, that each reservoir is to hold the drainage of 40 by 15 miles, or any other shape containing 600 square miles, we at once determine one point: that the dam must not be erected above the point commanding that drainage.

A second point may be determined without additional surveys: that in order to secure one of the important elements of these proposed reservoirs, namely, not over 4 feet per mile fall in the stream, it will be necessary to choose a site even farther still from the sources of the tributaries. It may even appear, that no such site exists on any of the smaller tributaries. And thus the future surveys may be materially limited in their scope. And perhaps, without further surveys, the question may be *settled*, whether numerous small reservoirs or a few large reservoirs, may be the proper plan of any system of artificial reservoirs. But, in the present stage of our investigation, we confine ourselves mainly to the general outlines laid down in Mr. Morris's paper. For the present, therefore, we pay no particular attention to the reservoir characteristics of streams below a point that will secure the available drainage of 600 sq. miles; though without granting that even at that distance from the sources, all the elements designated can be obtained. Let us look at this practically, by the light we can command.

Wheeling is the starting point; that being the place where the records of the height of the river and the measurements of its flow were made, upon which the reservoir plan as yet stands.

It is not very important that the tributaries flowing into the Ohio between Wheeling and Pittsburgh should be critically examined, now, or at any time, for the reason that if the reservoir plan should be adopted, the artificial supply must enter as high as Pittsburgh; the water failing there as much as at Wheeling in dry seasons, with a more rapid fall per mile. We will, however, briefly refer to the principal tributaries entering below Pittsburgh.

On the left or east bank occur, Short Creek, Cross Creek, Raccoon Creek, and Chartier's Creek. The largest, Chartier's Creek, drains an

area of only about 300 square miles; so that even with a dam at its mouth, it would only secure half enough for one reservoir. Raccoon Creek, the next in size, drains only about 160 square miles.

On the right or west bank occur, Wheeling Creek, Short Creek, Yellow Creek, Little Beaver River, and Big Beaver River.

Little Beaver River drains about 400 square miles. Yellow Creek about 200 square miles. The Little Beaver runs through a narrow valley, with but occasional bottom lands on the lower 20 miles of its course. New Lisbon, the capital of Columbiana County, Ohio, is situated on this stream, 25 miles from its mouth measured along its windings. Below New Lisbon, it rises at the rate of about 8 feet per mile; above New Lisbon it rises still more rapidly. The best place for a high dam on the Little Beaver, is near its mouth. A dam 100 feet high would, however, back the water but 12 miles instead of 25, and the pool it would form would contain less than 2,000,000 000, or not more than *one-fifth* of the available drainage of even 400 square mile. A dam at the point just named, would destroy several valuable mills, but not much valuable bottom land.

We next come to the Big Beaver River, 28 miles below Pittsburgh. This is long enough, and drains territory enough to meet *one* of the requirements for a *large reservoir*. Its extreme length from its sources at the heads of the Shenango in Ohio and Pennsylvania, being 120 miles. To obtain the drainage of 600 square miles, the dam must be placed as far down the Shenango as the vicinity of Sharon. From Sharon upward towards Greenville, the stream rises 5 feet per mile, above Greenville 7 feet per mile. A dam 100 feet high between Sharon and Clarksville, would back the water about 17 miles. It would flood Clarksville, Greenville, and several valuable mills, and destroy 17 miles of the Pennsylvania Erie Canal, now the property of a private corporation; and its pool would not contain more than one-third of the drainage of 600 sq. miles. At Greenville, the Shenango forks, and if a dam were built on either fork so as to save Greenville, it would not secure the drainage of more than 170 square miles on one fork, or 150 square miles on the other. The only resort then would be farther down the Beaver, or upon its Mahoning Branch. Taking the Mahoning, which enters the Beaver two miles below Newcastle, Pennsylvania, it will be found that to obtain the drainage of 600 square miles, the dam should be not far from Warren, the county seat of Trumbull, Ohio. A dam 100 feet high if placed below, would submerge Warren, 20 miles of the Pennsylvania and Ohio Canal, several valuable coal mines, mills, and excellent farm land, and a number of miles of the Cleveland and Mahoning Railroad. In fact, it is inadmissible there, or at any point between Warren and Newcastle. Just above Warren, a dam would secure the drainage of 600 square miles. Whether a dam of one hundred feet height would accomplish it, is not certain, but possibly it would, as the country is comparatively flat, and at the same time well improved and cultivated. It would require a very long dam, and would destroy 20 to 25 miles of the Cleveland and Mahoning Railroad, 20 to 25 miles of the canal, and much other property, involving very heavy damages. The land damages alone would not be less than a million of dollars independently of other damages

named, and the destruction of towns. The inhabitants of that region of country, would not permit the erection of such a structure. Practically, there is no place where such a work is admissible on the Mahoning branch of the Beaver.

The dernier resort, so far as the valley of the Big Beaver is concerned, would be the *main stream* between Brighton and Newcastle. There is already on that part a succession of dams forming the slackwater of the "Beaver Division," as it is called. A dam 100 feet high erected just above New Brighton, would back the water about as far as Newcastle, say 20 miles. It would form a pool that might average 35 feet deep for 1000 feet of average width in the main valley, and half as much more up the tributaries This would make a total of 7,920,000,000 cubic feet, or less than a third of the drainage of 600 square miles. The damages would not be very heavy except the cost of the *new locks* and towing path along the new pool, in view of the old locks, &c., for 100 feet of lockage. A few hundred thousand dollars perhaps, would cover all. This is undoubtedly the only place on any part of the Big Beaver where a large dam of the kind could ever be located, and yet even here, it would not afford one-third the quantity assumed as proper to such a dam.

Above the Big Beaver no tributary of consequence enters on the western side of the Ohio until we ascend to Pittsburgh, the veritable head of the river.

Starting at Pittsburgh, let us first take the Monongahela and its branches; beginning at the head waters of the Youghiougheny, in the State of Maryland.

It is less than 40 miles from its farthest source down to the Pennsylvania State line, and not more than 350 square miles are drained in Maryland. In order to obtain the drainage of 600 square miles, a site must be chosen in Pennsylvania, probably at the passage of the stream through Laurel Hill Ridge. But the fall in this part of the Youghiougheny is 10 *feet* per mile; so that a dam 100 feet high would back the water only 10 miles, and the pool created thereby would not probably contain more than *one-fourth* of the entire drainage of 600 square miles. According to data furnished in Mr. Ellet's paper, the fall in Youghiougheny even between Smethport and Connelsville is 393 feet, which must be more than 10 feet per mile. It is evident, therefore, that the Youghiougheny is not favorable for the establishment of one of the contemplated large reservoirs, unless it could be located towards its mouth, along the present slackwater navigation. In that event, it would of course involve the construction of 100 feet lift of new locks, besides the submerging of several towns, mills, coal banks, and other valuable property. None of the *tributaries* of the Youghiougheny would afford a site having any thing like the adequate extent of drainage.

We next proceed to the other head waters of the Monongahela. Take *Cheat River*, which enters the main stream within Pennsylvania, a few miles below the Virginia State line. It is a Virginia stream. In regard to this branch of the river, Mr. Ellet states, that in the first forty-seven miles above its junction with the West fork it falls 600 feet, or 13 feet per mile. It is obvious, therefore, that this will not meet a requirement based on a fall of only 4 feet per mile; and that a hundred feet dam,

instead of backing the water 25 miles, could only flow 8 miles; and that the quantity likely to be stored in such a pool, would fall very far short of the quantity assumed by Mr. Morris.

Next comes the West fork or main Monongahela River, also, a Virginia stream until it enters Pennsylvania, about ninety miles from Pittsburgh. The fall of this steam from Weston in Virginia, to the forks above mentioned, is only about two feet per mile. From the remarkable fact that the Monongahela River even so near to its head has so little fall, it may fairly be inferred that here is a favorable site for one of the pro posed large reservoirs.

The Monongahela Navigation Company would, it is to be presumed, favor and perhaps aid the construction of a large reservoir on the head waters in Virginia, as it would relieve them from the difficulty they now labor under in dry seasons for want of a sufficient supply of water. If made large enough to aid essentially in improving the navigation of the Ohio River, it would afford hydraulic power on the Monongahela of some value. The question yet to be determined on the Monongahela will be the proper location and probable cost of the structure necessary to form the reservoir. For this the writer does not possess the data. But its erection would involve the necessity of some efficient and convenient arrangement for passing the rafts and other descending craft of a body of owners and dealers jealous of their navigation and hydraulic rights and privileges.

Leaving the Monongahela, we will now proceed northward up the Allegheny, which is the main prolongation of the Ohio; taking first the right bank or west side, and dwelling but little on tributaries which drain only a small area of country. The first considerable tributary is Bull Creek, which enters just below Freeport, 27 miles above Pittsburgh, and that drains only 150 square miles. There is none even as large as Bull Creek, until we reach French Creek, 130 miles above Pittsburgh. The Allegheny River at the mouth of French Creek is 261 feet above the river at Pittsburgh, showing an average descent of 2 feet per mile on the whole distance.

French Creek is a very important tributary of the Allegheny River. It was gauged during the summer of 1839, under the direction of the writer, by James Worrall, Esq., Civ. Eng., and found to yield in round numbers 22,000 cubic feet per minute. It was a low stage, but not by any means its very lowest stage, but probably affording a fair criterion of its flow in *ordinary low* water. This stream rises within less than eight miles of Lake Erie, in Erie County, Pennsylvania, and in Chatauque County, New York. Near its head, the country is comparatively flat. A point 40 miles from its sources, would be near Meadville, above which flourishing town, the well known capital of Crawford County, a dam could be built which would be below the drainage of 600 square miles. The fall in French Creek for a distance of 15 to 20 miles above such point, is 4 feet per mile. A dam 100 feet high would therefore flow the water back about 25 miles; and, from the shape of the valley, it might perhaps hold half of the drainage of 550 square miles, which is about the area drained by French Creek above Meadville, leaving out, of course, the drainage of Cassawaga Creek, which enters below where the dam could be built.

Such a high dam would submerge several mills, several towns, numerous roads and houses, and much excellent and well improved farm land. If constructed, it would be necessary to furnish from its pool sufficient water for the supply of the French Creek feeder, a navigable canal 22 miles in length, and for 45 miles of the Conneaut line of the Erie canal, and 10 miles of the Shenango line, all of which being 77 miles of canal, are now *wholly supplied* from French Creek, from Bemus' Dam 2 miles above Meadville; and none of which supply returns again to any part of French Creek. The flow is about 7260 cubic feet per minute for about 8 months of the year; assuming the area to be 75 square feet, and the rate 1·1 miles per hour, where it passes the aqueduct. It may be, that the water power leases may require this flow for the entire twelve months. In that case it would take 50 per cent. more, and the total quantity would be for a year, 3,750,000,000 cubic feet.

Again, French Creek falls between Meadville and Franklin, (the capital of Venango County, at the mouth of the Creek,) 30 miles, at the rate of about 4 feet per mile, so that a dam 100 feet high would flow back 25 miles. But if built below and yet within 20 miles of Meadville, it would submerge it. It would also back the water up the Conneaut outlet, and overflow Conneaut Lake, and waste part of the water into the Shenango Valley, running southward into the Big Beaver River, and part into the Conneaut Creek, running northward to Lake Erie; for it is a curious fact, that the water from French Creek, which naturally belongs to the Ohio Valley, now forms the sole supply of 45 miles of the northern end of the Pennsylvania Erie Canal, and empties into the Lake at Erie. To admit of a 100 feet height of dam, the structure must be located within two or three miles of Franklin. Here the valley is more confined by tolerably steep hills, and the quantity that could be stored in a reservoir would be very much less. The damages would also be less, but still they would constitute a heavy bill of expense. Therefore, although theoretically there is a reasonably good site for *one* of the great reservoirs on French Creek, practically there are serious difficulties to be encountered and overcome. And at the best, no single dam of 100 feet height on French Creek would contain more than half the drainage of 600 square miles.

The next tributary of considerable size above French Creek, is Oil Creek; but it drains an area of only about 270 square miles. It falls 4 to 5 feet per mile.

Next in order is Brokenstraw Creek, draining only about 240 square miles.

Then comes the Connewango Creek, entering the Allegheny at Warren, the capital of Warren County, Pennsylvania. This Creek drains about 960 square miles, including Chatauque Lake, in Chatauque Co., New York. To secure the drainage of 600 square miles, the dam should be put not farther down than Frewsville, which is about 15 miles above Warren. The distance from Chatauque Lake to Warren, following the course of the Cassadaga and Connewango Creeks, is about 29 miles, and the fall 119 feet, or about 4 feet per mile. A dam near Frewsville, 100 feet high, would overflow Chatauque Lake about 40 feet; which it is presumed is not admissible. It would, therefore, have to be located

within 4 or 5 miles of Warren, across the main Connewango Creek. Not being personally acquainted with this stream, no further remarks in relation thereto will be made in this place. Possibly it may be favorable.

Above the mouth of the Connewango, there is no tributary of the Allegheny on the same side, whose area of drainage would approach the requirement of 600 square miles, or even half of it.

Returning to Pittsburgh, we take the left or east bank of the Allegheny River. Between Pittsburgh and Freeport, 28 miles, no tributary enters which drains more than about 50 square miles.

Just above Freeport, we meet the Kiskiminetas River, second only in importance to French Creek, in its extent of drainage and supply of water to the main river. It is over 100 miles long, and its sources are on the western slopes of the Allegheny Mountain, in Cambria and Somerset Counties, Pennsylvania. Forty miles from the most remote head of the Stony Creek branch, would extend below Johnstown, and as far down as the passage of the Conemaugh* River through *Chestnut Ridge*, a spur of the great Allegheny chain. A dam at Chestnut Ridge, would be below the drainage of about 700 square miles. But a dam built there, would be of great height if required to form a pool of sufficient size to contain the drainage of 600 square miles, as the valley is narrow, and the hills steep, between Chestnut Ridge and Laurel Hill, and for most of the distance from Laurel Hill to Johnstown; and the effect of such high dam would be to submerge Johnstown, the Pennsylvania Central Railroad, the State Canal, the State Railroad above Johnstown, and the Cambria Iron Works; in which latter more than a million and-a-half of dollars are invested. It would, besides, destroy a large amount of other valuable property. It may, therefore, be regarded as *impracticable* at any point that would flood Johnstown.

At Johnstown, the stream forks, this being the junction point of the Conemaugh River and Stony Creek. On the Conemaugh, or rather a branch of it, a reservoir has been constructed for the purpose of supplying the western division of the Pennsylvania Canal in dry times. It was built by the State, under the direction of Wm. E. Morris, Esq., Civil Engineer. It is said to contain 466,000,000 cubic feet of water, and to have cost $166,000. The Conemaugh Reservoir is entirely out of the way of injuring the public works; its location being south of the old Allegheny Portage Railroad. Whereas, owing to the location of the Pennsylvania Central, and the new State Railroad, in the immediate valley of the Conemaugh, all the way from Johnstown to its head, no large reservoir could possibly be permitted in this stream above Johnstown.

Stony Creek remains. The entire drainage of Stony Creek, and all its branches, is only about 400 square miles, or but two-thirds enough for one of the proposed large reservoirs. If, therefore, a dam were thrown across it near its mouth, in the vicinity of Johnstown, it would not hold the drainage from more than 300 square miles, unless it were more than 100 feet high; and the damages to mills and improved property would be heavy.

* Above the mouth of Blacklick Creek, just below Blairsville, the name of the main stream is Conemaugh, below that, Kiskiminetas.

Turning to the Conemaugh below Laurel Hill, and above Blairsville, we can find a point where a dam 100 feet high could be erected without very heavy damage to private property, because the valley is very narrow, and the side hills generally steep; but it would submerge a portion of the Pennsylvania Railroad, and involve the building of 10 or 12 new locks on the Pennsylvania Canal, and a very complicated arrangement that would permit the pool to be emptied for supplying the Ohio River, without seriously incommoding the *canal navigation*. But owing to the contracted width of the valley, and the amount of fall in the stream, the pool would not contain one-third of the drainage of 600 square miles.

Below Blairsville, the principal tributary of the Kiskiminetas, is the Loyalhanna, a fine stream, but draining only about 300 square miles. A very high dam at or near its mouth might control the drainage of that area, but the damages to valuable farms, buildings, and mill property would be very great.

Blacklick Creek, the only other remaining tributary worthy of notice, entering the Kiskiminetas below Blairsville, drains somewhat less than 300 square miles.

We then come to the main Kiskiminetas River, the fall in which is about 4 feet per mile. A dam 100 feet high would therefore flow back about 25 miles. The valley at the height of an average of 50 feet above the present low water, would be about 1200 feet wide. Such a reservoir would probably contain, including the flow back along the tributaries, about 8,000,000,000 of cubic feet, or not quite one-third of the requirement for one of the large reservoirs; and about one-half of the drainage of 600 square miles, allowing 12 inches per annum as available. It would require the construction of 100 feet vertical of new locks, or 10 locks of 10 feet lift each, and some new and peculiar arrangement to allow for the gradual drawing down of the pool, so as to maintain the canal navigation as the water should be discharged for supplying the Ohio River. It would submerge 20 or more miles of the "North Western Railroad," and destroy not less than twenty valuable salt wells, several considerable towns—Leechburg, Warren, Saltzburg, or at least two of them, and several very valuable water-powers. The damage to landed property would not be heavy. The dam would have to be located far enough above the mouth of the Kiskiminetas, to leave room for the North Western Railroad to be rebuilt on a new route with a moderate grade, as in the vicinity of the dam the railroad would necessarily have to be about 110 feet above the present surface of the water. This would make the new route of the road much more costly than the old one, on account of the expensive crossing of the tributaries at a higher level.

Leaving the Kiskiminetas, we come to Crooked Creek, which drains only about 280 square miles, and enters the river a few miles below Kittanning. Its valley is narrow, and it has a rapid fall, and is not well adapted for the purpose of a single large reservoir. Next is the Cowanshanoc, which enters a short distances above Kittanning. It does not drain over 75 square miles, and falls more than 10 feet to the mile.

Next above is the *Mahoning*—a fine stream, draining nearly 400 square miles. Its valley is very narrow, and bounded by steep side

hills. Its average width at the height of 50 feet above low water, is not more than 600 feet; and it falls so rapidly (8 feet per mile), that a dam even at its mouth, 100 feet high, would not back the water more than about 12 miles.

Next we have Red Bank, another fine stream. This drains about 650 square miles. Its valley is rather wider than that of the Mahoning. Between its mouth and the town of Bethlehem, it may average, at 50 feet above low water, 900 feet wide. It falls here at the rate of 7½ feet per mile; so that a dam at the mouth, or any where between the mouth and Bethlehem, 100 feet high, would flow back only about 13½ miles. Such a pool would probably contain about 3,300,000,000 cubic feet, or about one-sixth of the drainage of 600 square miles Above Bethlehem the valley is wide, and the country well improved. A dam on the stream above Bethlehem would hold more than one below, but it would lose part of the drainage, and the damages would be much heavier.

Both the Mahoning and Red Bank, which are navigable for descending craft, and out of which an immense amount of lumber and timber is annually rafted, would have to be arranged so as to secure the safe passage of rafts, &c. A dam above Bethlehem would also submerge the located track of the Allegheny Valley Railroad. Above Brookville, which is the capital of Jefferson County, the stream has more fall, and becomes less and less advantageous as reservoir ground; the heads of the streams falling more than 30 feet in a mile.

We come now to the Clarion River, about 85 miles above Pittsburgh. This is the largest tributary above the Kiskiminetas on the same side, and drains about 1400 square miles. From the town of Clarion, the capital of Clarion County, down to Callansburg, near the mouth of Big Licking branch, it has a fall of 6¼ feet per mile, with an average width of about 200 feet, and as high as Ridgway, the capital of Elk County. Above Ridgway it forks, and both forks have more than 7 feet fall per mile, until within a few miles of their heads, where they are quite abrupt, falling off more than 50 feet per mile. A dam to secure the drainage of 600 square miles, should be located as far down as Ridgway. In order to save Ridgway it would be necessary to place the dam, if built 100 feet high, about 15 miles below Ridgway, or farther. The valley of the Clarion River, between Ridgway and Clarion, is generally quite narrow. On much of the distance there is scarcely any bottom land, and the hill sides are tolerably steep; but not so steep as on the Mahoning. At the height of 50 feet above low water, the average width may be 1000 feet or rather more. Assuming it to be even 1200 feet, the pool of a dam 100 feet high, would hold about 5,300,000,000 cubic feet, or not quite one-third of the drainage of 600 square miles, 1 foot deep.

A dam *above* Ridgway would not catch the drainage of more than 250 square miles, and if built 100 feet high, it would not hold more than half of that drainage on account of the rise in the bed of the stream, and the shape of the valley; the rise from Ridgway up, being at first 7 feet per mile, gradually increasing to more than 50 feet per mile. It is probable, then, that the most advantageous site for a large reservoir any where on the Clarion waters, will be found between Clarion and Ridgway

where the fall is about 6¼ feet per mile. But there is no point on the entire river where a single dam 100 feet high will back the water 25 miles, or be likely to form a reservoir holding half of the quantity required for one of the large reservoirs.

Next comes the *Tionesta*, about 35 miles above Franklin, which with its Raccoon fork, drains about 500 square miles. The Tionesta is much more rapid than the Clarion, and runs for the most part through the wildest region of Pennsylvania, in the shades of deep and steep gorges. Although damages on this stream would be an unimportant item, the contracted width of the valley, and the abrupt declivities of its sides would make costly reservoir work, if attempted on the large scale. Ascending the stream in search of a favorable location will be useless, as the ascent increases until its upper waters rise more than fifty feet per mile.

Next is the Kenjua Creek, of very similar general features, but draining only about 200 square miles, and not favorable for large reservoirs.

The last tributary of the Allegheny River, on the same side, deserving notice in this connexion is Potato Creek, and this drains only about 150 square miles. A high dam could not be built at its mouth, for two reasons: because the valley is very wide (nearly a mile, much wider than any part of the main river valley below Olean), and because it would submerge Smethport, the capital of McKean County, Pennsylvania. If built above Smethport, it would not drain more than 80 square miles. The Potato Creek is remarkable for its *wide valley* and very *slight fall*—only about 2 feet per mile from its mouth for 13 miles up; but as it gradually decreases in width towards its upper end, the fall in the stream becomes very abrupt like the other head waters.

Having thus traced the general characteristics of all the tributaries of the Allegheny River, approaching in extent of area drained the dimensions necessary for large reservoirs, let us now look at the main stream itself. Beginning at Coudersport, the capital of Potter County, Pennsylvania, which is within less than 10 miles of its extreme sources, we should secure only about 70 square miles; and here the main valley is much narrower than it is a few miles farther down, and the river descends rapidly; too much so for the economical saving of water on a large scale. We should be forced down as far as the mouth of Potato Creek, before we could command 250 square miles of territory for drainage. Even at the State line, where the river first enters New York, there would be but 500 square miles, including all of Potato Creek drainage. In two respects, the vicinity of the State line is advantageous as a site for a high dam; the hills approach each other within about half a mile, and the valley soon *widens out* above the line, and the fall in the main river is only about 2 feet per mile; but unfortunately a dam less than half of 100 feet in height would flood *Smethport*, Eldred, Kingsville, and numerous dwellings and fine farms, besides several important mills.

This flat-place, as it may be termed, in the Allegheny River, is a very peculiar feature, to which particular reference was made in one of the writer's reports a few years since. The course of the river for about 10 miles is almost due north, whilst its general direction is south. In

an engineering view, the point at the State line presents as favorable a site for the erection of a large dam for a reservoir as *any* above Wheeling; but even here, it could not catch the drainage of over 500 square miles.

The lumbering interests along this part of the Allegheny River, are *very important*, and cannot by any chance be overlooked in considering any reservoir arrangements. Proper provision would have to be made for the safe and convenient passage of a heavy trade in which nearly every individual in the region is in some manner associated. As secondary to this, it may be proper to mention that the Allegheny Valley Railroad is located along the bottom land between the State line and Smethport, and also, that a company has been incorporated to construct a slackwater navigation, designed chiefly for the great coal field of McKean County.

But before proceeding farther down the main river, let us briefly recapitulate the results of the foregoing preliminary investigations among the tributaries.

(To be Continued.)

AMERICAN PATENTS.

List of American Patents which issued from April 28th, to May 5th, 1857, (inclusive,) with Exemplifications.

APRIL 28.

176. For an *Improved Method of Manufacturing Raw Hide Whips;* Charles Bæder, Brooklyn, New York.

"My invention consists in making raw hide whips of a simple piece of hide, without a core or filling, the hide having only a slight twist given it."

Claim.—"Constructing raw hide whips without a core or filler, and giving the wrappers a slight twist."

177. For an *Improvement in Harvesting Machines;* J. F. Barrett, North Granville, New York.

"The nature of my invention consists in combining with a cutter or cutters, moving in a straight line parallel with the line of motion, oscillating or swiveling knives, which swing upon cutters, which move in a line parallel with the line of motion of the carriage."

Claim.—"The combination of the straight forward and back moving knife, or its equivalent, with the oscillating or swiveling knives."

178. For an *Improved Apparatus for Binding Grain;* J. F. Barrett, North Granville, New York.

"The object of this invention is to facilitate the binding of grain by manual agency. The nature of the invention consists in facilitating the twisting of the band by jaws, closed at the will of the operator, and made to revolve simultaneously with their grasping."

Claim.—"Twisting or tightening the band after it has been crossed upon the sheaf by the operator, by means of jaws working in balanced shaft, in combination with the devices for simultaneously closing and rotating said jaws."

179. For an *Improvement in Fire Arms;* Gustav A. Blittkowski, City of New York.

"My invention of improvements in breech loading fire arms consists in a peculiar method of constructing and operating certain parts at the breech, together with the lock, whereby I obtain greater security against accidental discharge, effect a perfect joint at the union of the breech piece with the barrel, together with great simplicity of parts."

Claim.—"The rotating and oscillating breech piece for receiving the charges, so attached to the stock as to be capable of being withdrawn from the end of the barrel, and elevated to receive the charge and to be returned thereto with a grinding and wedging action, whereby a secure and tight joint is effected. Also, the safety guard upon the end of the breech piece, so placed as to prevent the cock from striking the nipple, until the said breech piece is secured in the barrel."

180. For an *Improved Mode of Constructing Lockets, &c.;* Charles G. Bloomer, Wickford, Rhode Island.

Claim.—"1st, The making of locket rims out of single pieces of metal, instead of two or more. 2d, The making of them out of sheet metal instead of wire. 3d, The making of them, substantially in the manner described."

181. For an *Improved Side-walk Pavement;* John B. Cornell, City of New York.

Claim.—"Casting in one piece a section of a street gutter and curb of suitable shape and proportions. Also, forming the side-walk pavement of a series of metallic plates, when said plates are combined with each other, and with the aforesaid metallic street gutter and curb."

182. For an *Improvement in Locks;* Leger Diss, Ilion, New York.

Claim.—"The combination of the stop-holder, self-spreading stops, and the spring, with the tumbler moving the stop-holder and needle block. Also, the needle block, as attached to the stop-holder, with its series of needles or pins operating on the stops. Also, the key block; and also, the needle key fitted to its position."

183. For an *Improvement in Gilding and Ornamenting Steel and other Metals;* Alexander H. Dufresne, Paris, France; patented in France May 14, 1856.

Claim.—"1st, The application of gold and silver to metals incapable of direct amalgamation. 2d, The employment of photographic, heliographic, and printing processes, for the production of the reserves on the metallic surfaces to be operated on. 3d, The use of chromic acid for the destruction of the nickel, copper, antimony, or other metal employed in these processes."

184. For an *Improved Machine for Mortising the Stiles upon Blind Slats;* D. F. Drake, Leominster, Massachusetts.

Claim.—"The machine for cutting mortises for window blind slats, consisting essentially in the carriages, in combination with the cutters and bits."

185. For an *Arrangement of Ports in Steam Cylinders;* Bowen Eaton, Roanoke, Ia.

Claim.—"The arrangement of the central exhaust and end steam ports, for the admission of steam at each end of the cylinder only, and its eduction from the central part only—the latter being controlled entirely by the piston of the engine cylinder."

186. For an *Improvement in Fire Arms;* Josiah Ellis, Pittsburgh, Pennsylvania.

Claim.—"The arrangement of the traverse lever to permit of its playing on the same centre as the hammer, without danger of lateral derangement. Also, the use of the cam in the lock plate, in combination with the shoulder on the traverse lever, for the purpose of withdrawing the point of the traverse lever from the radial grooves in the rotating breech, in the reaction of the trigger. Also, the combination of the radial beveled grooves, in the rear end of the rotating breech, with the traverse lever, as applied to trigger cocking fire-arms, for the purpose of rotating and locking the breech preparatory to firing."

187. For an *Improvement in Seed Drills;* Ezra Emmert, Franklin Grove, Illinois.

Claim.—"The arrangement and combination of the wheels with the extension pieces."

188. For an *Improvement in Seed Planters;* George M. Evans, Pittsburgh, Pa.

"The nature of my invention relates to the adjustable fender surrounding the front and sides of the seed planter, for the double purpose of adjusting the depth at which the shoe shall run, and for shielding the supporting wheels and shoe from clods, &c., whereby the machine would be otherwise raised or lowered, or thrown from its direct path, by any obstructions meeting it."

Claim.—"The so uniting of the wheel and guard frame to the beam, and to the rods or bars, as that the operator may, from his position between the handles of the machine, adjust the depth at which the shoe shall open the furrow, by moving said wheel and guard frame forward or back."

189. For an *Improved Machine for Engraving Designs on Watch and Locket Cases, &c.;* Charles H. Field, Providence, Rhode Island.

Claim.—"The variable pattern disk, and the combination of the same with the stud for governing the cutting of the tool. Also, the combination and arrangement of the tappets and the stud; also, the tappet in connexion with the same, for imparting and regulating the motion of the pattern disk; also, the arm and the lever, and the mechanism attached thereto—the whole being so combined and arranged as to render the material self-operating. Also, the adjustable pitman for imparting the required motion to the vertical sliding plate."

190. For an *Improvement in Ink-stands;* Kingston Goddard, Philadelphia, Penna.

Claim.—"The application of the bent tube to a common ink bottle, whereby said common ink bottle is converted into an effective and economical fountain ink-stand."

191. For an *Improved Action for Grand Pianos;* Daniel F. Haasz, Philadelphia, Pa.

Claim.—"1st, Attaching the supporter to the key, and the lever and spring to the supporter. 2d, The arrester, with the lever as connected to the key, in combination with the adjustable wire as attached to the key frame."

192. For an *Improved Machine for Cutting Indexes to Blank Books;* George Hodgkinson and Theodore F. Randolph, Cincinnati, Ohio.

Claim.—"The arrangement of the machine."

193. For an *Improvement in Chronometric Locks;* Amos Holbrook, Milford, and Henry D. Fish, Hardwick, Massachusetts.

Claim.—"The confining of the frame bolt, and the releasing of the same, by means of the jointed portion, the embracing pawls and release levers, operated by said locks. Also, the partial setting back of the independent locking spring bolts, by means of the spring catch, until the closing of the door."

194. For an *Improvement in Harvester Frames;* M. G Hubbard, Penn Yan, N. Y.

Claim.—"Joining the parts of the frame by means of the lock plates or irons and bolts, so as to make a firm and rigid union between the parts at a small cost."

195. For a *Preparation of Photographic Pictures, Engravings, &c.;* S. Dwight Humphrey, City of New York.

Claim.—"As an improvement of the patent of J. B. Hall, the use of a semi-transparent media interposed between two transparent photographic pictures or engravings, for the purpose of blending the rays of light reflected from the rear colored photograph, and beautifying the picture."

196. For an *Improved Saw Gummer;* Oliver B. Judd, Little Falls, New York.

Claim.—"The method of constructing and arranging the posts, so as to cause the cutter to move in regular curves."

197. For an *Improvement in Atmospheric Pumps;* Levi Keiler, Catawissa, Pa.

"The nature of my invention consists in a certain arrangement for causing the elevation of water from mines by the condensation of air in a simple and effectual manner."

Claim.—"The combination of the water receiver and air induction pipe with the valve, acting with respect to the openings, when said parts are arranged with respect to air condenser and discharge pipe."

198. For an *Improvement in Brushes of Saw Cotton Gins;* Edwin Keith, Bridgewater, Massachusetts.

Claim.—"Inclining the heads of the brush cylinder from the periphery towards the centre, and opening the passages through the heads."

199. For an *Improvement in Submerged Propelling Wheels;* Thomas Kendall, Sen., San Francisco, California.

Claim.—"The means for feathering or changing the positions of the wings, consisting of the cam plates, concentric ring, and curved plate, with its slopes or planes."

200. For an *Improvement in Harvesters;* Isaiah Knauer, Valley Forge, Penna.

"The object of my invention is to prevent the access of dirt to the mechanism, by which the cutter bar is reciprocated, and provide for the constant lubrication of the same."

Claim.—"The peculiarly constructed close box, in combination with guides and cover."

201. For an *Improved Street Sprinkler;* Curtis O. Luce, Brandon, Vermont.

Claim.—"The combination of the water reservoir, horizontal, rotating, discharging wheels, operated from the wheels of the carriage, and the conveying pipes, provided with the cocks."

202. For an *Improvement in Churns;* H. N. Mackey, Morgantown, Virginia.

Claim.—"The combination of the oblique wings, with the double-headed self-acting pistons passing through them."

203. For an *Improvement in Revolving Last Holders;* Benjamin Marshall, Philadelphia, Pennsylvania.

"The object of my invention is to meet the demands for such an article at the present day as will enable mechanics engaged in the manufacture of boots and shoes, to perform their work with greater ease and facility, than by any other means now known or used to accomplish the said object."

Claim.—"1st, The screw and nut, in combination with the inclined plane, for the purpose of raising and lowering the toe-rest, and moving it back and forth. 2d, The combined arrangement of the crank or eccentric, with the revolving shaft, and the attachment of the elastic band, or its equivalent, at the waist, and at the set screw."

204. For an *Improvement in Securing and Guiding the Boxes of Oil Presses;* Wm. W. Marsh, Jacksonville, Illinois.

Claim.—"The employment upon the upper sides of the trusses of longitudinal guides, of such form that while they serve to conduct the boxes to and from the press, and to confine the hinged side against the outward pressure, they also serve to connect the trusses with the boxes."

205. For an *Improved Mode of Constructimg Photographic Baths and Pans;* George Mathiot, Washington, District of Columbia.

Claim.—"To construct the baths and vessels for photographic use of an impervious substance, formed by the combination of a cement with an earthy matter, or its equivalent; and also to form the bath, or other vessel, by first forming the vessel of unglazed pottery, or its equivalent, and making the pottery impervious by saturating it with wax, gum, balsam, resin, pitch, stearine or siccative oil, or the equivalent for any one of these."

206. For an *Improvement in Metallic Canisters for Putting up Paints, &c.;* John W. Masury, Brooklyn, New York.

"The nature of my invention consists in the construction of a metallic vessel, with a sliding and revolving bail or handle, in such a style that it shall or may be substituted for wooden kegs, in the packing for sale or transportation of whole lead, zinc, and other paints."

Claim.—"The use of metallic cans for putting up paint, or other substances of any known form, with ears attached thereto, through which a wire bail may be passed, in such a manner as not to interfere with the packing of the cans, and to render it at once a package for transporting the paint, and a convenient and useful pot or pail, out of which to use the same, with a removable cover secured to the can."

207. For an *Improvement in Cop Tubes;* John Marland and Earlsworth Crocket, Lawrence, Massachusetts.

Claim.—"A cop tube formed of gutta percha."

208. For an *Improvement in Sails and Rigging of Vessels;* George T. May, Tompkinsville, New York.

Claim.—"The use of the self-supporting 'set' of masts, whether the same is composed of two or more masts, they being stayed and sustained by rigging, whose spread at the line of the deck shall not exceed the lines of the distance between the forward part of the pivot mast, and the forward part of the spring mast of the set."

209. For an *Improvement in Washing Machines;* Josiah Mayes, Cohoes, New York.

"This invention consists in the peculiar manner of arranging beaded strips upon the bottom of the tub and the face of the rubber, whereby the clothes will be subjected to a more perfect rubbing action than in the usual machine of this kind."

Claim.—"Attaching the beaded strips to the bottom of the tub and the face of the rubber."

210. For an *Improvement in Tempering Steel Plates;* Henry A. Seymour, Bristol, Connecticut.

Claim.—"The employment of the perforated plates and water cooling boxes."

211. For an *Improvement in Bomb Lances;* Rufus Sibley, Greenville, Connecticut.

Claim.—"Causing a bomb lance or projectile to take the wings that are to guide it through the air or water, from the muzzle of the gun from which it is discharged. Also, sloping the nozzle of the gun so that the wings may come back and close down to the barrel."

212. For an *Improved Excavator;* Samuel W. Soule, St. Louis, Missouri.

Claim.—"The frame, lever, lugs, rod, and pins or lugs, and their projection, or their equivalents, for the purpose of mechanically operating a scraper."

213. For an *Improved Machine for Tenoning Blind Slats;* La Fayette Stevens, Elmira, New York.

"The nature of my invention consists in improvements in the mandrel head and sliding table and gauge, for regulating the length of the tenon to be cut, and the use of a spur for cutting off the end of the tenon."

Claim.—"The movable and reversible gauge, in combination with the sliding table, arranged and operating in connexion with the mandrel head as made, and cutters and spur."

214. For an *Improvement in Self-adjusting Sack-holders;* Augustus Stoner, Mount Joy, Pennsylvania.

"The nature of my invention consists in supplying the place of a hand, so that a farmer, or others, can fill up bags without an assistant."

Claim.—"The spring and the adjustable base, by means of the screw and burr, and piece and hopper."

215. For an *Improved Mode of Constructing Letters for Signs, &c.;* Thomas Motley, Brooklyn, New York.

Claim.—"The new manufacture of frame or skeleton letters, that is, the outline of each letter or numeral is formed of a skeleton frame, open both front and back, or entirely through."

216. For an *Improved Wind-Mill;* Rufus Nutting, Randolph, Vermont.

Claim.—"The construction of a horizontal wind power, with a regulator or clasp operated by centrifugal force, which shall regulate the amount of surface of wing or sail opened to the wind. Also, an arrangement by which the regulator or clasp may be conveniently set at any time by the operator in such position as to prevent the wings from opening too far."

217. For an *Improved Method of Setting Head Blocks of Saw-Mills;* Ira Robbins, Unityville, Pennsylvania.

Claim.—"The combination of the lever catch, springs, cords, weight, stud, and lever, in connexion with the lever."

218. For an *Improved Machine for Planing Hoops;* Thaddeus S. Scoville, Elmira, New York.

Claim.—"The employment of a concave guide arranged with a hinged portion immediately before the cutters, which is held in place by a spring having less pressing force than the counter gauge roller, in combination with said gauge roller, or its equivalent."

219. For an *Improvement in Machinery for Winding Wadding;* Thomas Thompson, Niverville, New York.

Claim.—"The apparatus for removing the full roller, and supplying or depositing the empty roller, or the equivalent thereof. Also, the devices covered by the first claim, or their equivalents, in combination with the rollers arranged to divide or break the wadding or other material."

220. For an *Improvement in Railroad Chair Machines;* Corydon Winch, Jersey City, New Jersey.

Claim.—"The two bending and upsetting arms or bars, having their upper surfaces

made inclined, and provided with ledges or flanches at their inner edges, the bars being operated or moved so as to both bend and upset the lips, and thereby increase the thickness and consequently the strength of the lips where most required, viz: at the junction of the lips with the plate or base of the chair."

221. For an *Improvement in Skates;* John A. Winslow, Roxbury, Massachusetts.

Claim.—"The application of a second metal runner to the skate, which being placed on the bottom outside of the central line of axis, and the runner in the ordinary skate which lies along that line, removed to a correspondent position on the other side, completes the improvement."

222. For an *Improvement in Washing Machines;* Henry D. Young, Junius, N. Y.

"The nature of my invention relates to the peculiar method of constructing my washing rubber, and to the manner of tightening the apron on which the clothes are placed to be washed, and also of the manner of driving the washing rubber and apron."

Claim.—"The mode of operating the apron to give its surface a slower motion than the surface of the rubber, in combination with the shaft and apron, the side plate and hook, constructed and operated."

223. For an *Improvement in Purifying Oils;* Halvor Halvorson, Cambridge, Assignor to self, Edward H. Baker, J. F. Anthearu, and W. Tracy Eustis, Boston, Mass.

"The nature of my invention or discovery consists in the separation of the solid from the liquid constituents of fat by certain chemical means."

Claim.—"The employment of alcoholic solutions of alkali."

224. For an *Improvement in Anchor Trippers;* John B. Holmes, Assignor to self and John R. Pratt, City of New York.

Claim.—"The combination of the thread or screw working in a spiral groove or nut with the shaft or bolt, whereby I am enabled to relieve the chain, and trip the anchor at an instant."

225. For an *Improved Method of Operating the Chisels of Mortising Machines;* Moses Marshall, Assignor to self and Russell Dyer, Lowell, Mass.

Claim.—"The projection on the pawl, so constructed and arranged as to press back the bolt when moved in one direction, and release the collar, so that it may be turned by the pawl to reverse the chisel, and also that it, the projection, will pass outside the pin when moved in the other direction. Also, the slotted lever, chain, and lever, or their equivalent, so constructed and arranged as to turn the collar, and reverse the chisel."

226. For an *Improvement in Machines for Making Paper Bags;* Benjamin F. Rice, Assignor to Benjamin R. Smith and Charles H. Morgan, Clinton, Mass.

Claim.—"A combination or machine composed of machinery for bending a strip of paper around a former and into a tubular form, so that one edge may be lapped over the other, machinery for pasting such edges, or one of them, and closing or pressing them together, and machinery for cutting the tube crosswise. Also, the combination of machinery for bending a strip of paper around a former and into a tubular shape, so that one edge may be lapped over the other, machinery for pasting such edges, or one of them, and pressing them together, machinery for cutting the tube slantwise, while it is on the former or holder, and machinery for pasting or cementing the said tube near its front end, and bending or lapping the end of the tube on the cemented part, so as to form the bottom of the bag, and discharge said bag from the machine. Also, arranging the pitch line of the feeding gear in or about in the prolongation of the axis of the shaft of its crank, whereby we obtain intermittent and variable motions of the paper. Also, arranging and operating the cutting knife with respect to the former, so as to cause said knife to cut obliquely across the end of the former, and through the tube of paper. Also, the combination of the paster, and bending and discharging rollers, or their equivalent, the whole being made to operate together. Also, combining with the rollers the mouth bars or scrapers. Also, the improved construction of the cutting knife, viz: with a serrated edge."

227. For an *Improvement in Gauges for Casks;* John W. Cochran, City of N. York.

Claim.—"1st, The arrangement of the sliding plungers and set screws in relation to the connecting rods and measuring arms, by which I am enabled to work each arm independent from the other, and gauge casks or vessels, whether the bung hole is in the centre, in the head, or elsewhere. 2d, Making the measuring arm adjustable."

228. For an *Improved Machine for Splitting Wood;* Waterman L. Ormsby, Jersey City, New Jersey.

Claim.—"1st, The arrangement of the chisels in broken or serrated, and in diagonal lines, according to the nature of the wood to be split. 2d, The arrangement by which the apices of one row do not coincide, but alternate with those of an opposite row. 3d, The feeding apparatus and clamp, inclined as represented, by which sticks put into the feeding boxes require no further attention or handling till they drop as kindling wood from the splitting chisels. 4th, The combination of the feeding, sawing, and splitting apparatus, by which greater economy of time and power in preparing kindling wood is achieved than has been hitherto attained. 5th, The combination of the guide grooves in the flanch of the hopper, thereby avoiding the introduction of separate guide plates for the chisels."

Additional Improvements.

1. For an *Improved Filter;* David N. B. Coffin, Jr., Newton Centre, Mass.; patented Sept. 2, 1856; additional dated April 14, 1857.

Claim.—"1st, So constructing that part of the filter to which the filtering medium is attached, and providing it with a seat in the case, that it may be raised from said seat or turned upon it so that the water shall be free to pass in from the faucet, through and around the filtering diaphragm, in such manner as to wash away the impurities from the surface of the diaphragm; also, to relieve the force of the stream of water when drawn without filtering. 2d, In combination with the ring, the flanch for holding in their place the additional layes. 3d, The grooves on the outer surface, in combination with the ring, whether separate or continuous, like the thread of a screw, with or without a corresponding inside screw formed in the ring for greater certainty in holding the diaphragm, also the rebate, so that the ring may reach a little below the largest part."

2. For an *Improvement in Safety Hatches for Ware-houses;* William H. Thompson and Eustis P. Morgan, Biddeford, Maine: patented June 24, 1856; additional dated April 14, 1857.

Claim.—"The opening and closing of vertical doors attached to the tube or box of an elevator, by means of the action of a traversing car or platform, and its attachments."

Re-Issues.

1. For an *Improved Portable Steam Cross-cut Sawing Machine;* Samuel R. Wilmot, Watertown, Connecticut; patented August 14, 1855; re-issued April 7, 1857.

Claim.—"The combination of a saw, and a direct-acting engine for driving it, with an apparatus for securing the whole to the object to be sawed, in such a manner that the latter forms the support or basis by which the steam cylinder is maintained in the proper position."

2. For *Improved Carpenters' Gauges;* Joel Bryant, Brooklyn, New York; patented August 19, 1856; re-issued April 14, 1857.

Claim.—"The invention and exclusive use of point holders, or holders for the points, markers or cutters of gauges and instruments equivalent thereto, irrespective of any particular or definite form or kind of gauge, and irrespective of any definite form or kind of holder, means or contrivances, having a screw thread cut within the same, and corresponding with a screw thread cut upon the said points, markers, or cutters, so as that the said points, markers, or cutters, are operated within the said holders, to be raised or lowered through the instrumentality of the said screw threads within the said holders, and upon the said points, markers, or cutters, of the said gauges, or instruments equivalent thereto."

3. For an *Improvement in Reaping Machines;* Obed Hussey, Baltimore, Maryland; patented August 7, 1847; re-issued April 14, 1857.

Claim.—"The combination of a vibrating scalloped cutter, the indentations of whose edge act as a series of mooring shear blades, with slotted guard fingers, the sides of which act as a corresponding series of fixed shear blades, the parts of such fingers forming the slot, being connected at the front ends only, leaving the rear of the slot open and free for the escape of material that would otherwise clog the cutter."

4. For an *Improvement in Reaping Machines;* Obed Hussey, Baltimore, Maryland; patented August 7, 1847; re-issued April 14, 1857.

Claim.—"The improved beveling of the edges of the blades of scalloped sickles."

5. For an *Improvement in Reaping Machines;* Obed Hussey, Baltimore, Maryland.

Claim.—"The combination of a slot formed between the long and short parts of the guard finger, with an opening in the rear of the short part."

6. For an *Improvement in Sewing Machines;* Joseph P. Martin, Philadelphia, Pennsylvania, Assignor of John A. Bradshaw, Lowell, Massachusetts; patented Nov. 28, 1848; re-issued April 14, 1857.

Claim.—"Regulating the tension of the thread after it has been unwound from the bobbin by means of apertures and bars, within, upon, or through the thread case, either separate or combined, or by any equivalent means, when said means are within, upon, or form part of the bobbin case itself. Also, regulating the tension of the shuttle thread in the act of leaving the bobbin by a combination of one or more screws with a spring or any yielding or elastic substances, or any equivalent devices for producing the same effect."

7. For an *Improvement in Sewing Machines;* Joseph P. Martin, Philadelphia, Pa., Assignee of John A. Bradshaw, Lowell, Mass.; patented Nov. 28, 1848; re-issued April 14, 1857.

Claim.—"The covered shuttle to be used as a sewing machine, or in other words, constructing that portion of the bobbin case which comes in contact with the top, cylindrical, or in any other form which does not present edges in its transverse sections."

8. For an *Improvement in Looms;* Warren W. Dutcher, Milford, Mass.; patented June 27, 1846; re-issued April 21, 1857.

Claim.—"Supporting the way staff at its lower end, so that it may slide longitudinally, in connexion with supporting it in other respects by a joint link, or its equivalent, applied so as to cause that part of the staff which strikes the shuttle to move in a line parallel or about parallel to the race beam. Also, connecting the lower end of the two staffs below their fulcra, by means of a spring having an intermittent action for drawing them back, in combination with the application of a positive motion above for driving the shuttle, whereby the returning staff aids in arresting the momentum of the shuttle."

9. For an *Improvement in Refrigerators;* D. W. C. Sandford, St. Louis, Missouri; patented Nov. 13, 1855; re-issued April 21, 1857.

Claim.—"The employment of an open bottom ice-box, or equivalent thereof, in combination with a dividing partition open above and below, so placed that by means of self-operating internal circulation, the whole of the contained air shall be kept in motion, and caused to revolve around this partition in currents, moving downwards only on one side of this partition, and upwards only on the other side, when the same is combined with a chamber for the refrigeration of food or provisions, placed directly under said ice-box. Also, placing shelves of fixtures for holding articles to be refrigerated, or the articles themselves, in the descending current directly under an open bottom ice-box, in combination with a dividing partition open above and below. Also, in combination with said shelves or fixtures so placed, constructing the open bottom of the ice-box, in such a manner that the air may pass freely down through the same, and fall directly from the ice upon the articles to be refrigerated, while at the same time the drip of the water is prevented."

10. For an *Improved Hinge for Picture Cases;* A. P. Critchlow & Co., Assignees of Alfred P. Critchlow, Florence, Massachusetts; patented October 14, 1856; re-issued April 21, 1857.

Claim.—"My improvement in the application of a hinge of a daguerreotype or picture case moulded of a plastic material, or made of a flanchible substance or substances, such being made with each of its leaves being bent twice, and so applied to the halves of the box, that it may not only embrace two contiguous sides of such halves, and be independent thereof, or not have any tenon or projection to enter the same, but may extend or lap over and be fastened to the top and bottom plates of said box."

11. For an *Improvement in Seed Drills;* James Selby, Lancaster, Ohio; patented June 19, 1855; re-issued April 21, 1857.

Claim.—"Regulating at pleasure the quantity of seed discharged by means of the transverse slides, or their equivalent."

12. For an *Improved Saw-mill for Re-sawing Boards and other lumber;* Pearson Crosby, Fredonia, New York; patented Nov. 3, 1841; re-issued March 10, 1849; extended October 30, 1855; re-re-issued April 28, 1857.

Claim.—"The mode of operation of gauging, guiding, and presenting boards to the action of a saw, which mode of operation results from combining with a slitting saw the mechanism for gauging and guiding one face of the boards, and the mechanism for making a self-adjusting pressure on the opposite face of the boards, so that the boards will be clamped between the two said mechanisms on opposite faces, and immediately in front of the cutting edge of the saw, so as to prevent the gauged face of the boards however warped or bent they may be, in a plane parallel with the plane of the saw. Also, in combination with a slitting saw, and the arrangement of the gauge and pressure rollers connecting the said gauge and pressure rollers with the mechanism from which they derive motion by means of universal joints. Also, the method of hanging and straining the saw, by the combination of the three stirrups at the ends of the saw."

13. For an *Improvement in Gas Burners;* Charles H. Johnson, Boston, Mass.; patented June 26, 1855; additional March 18, 1856; re-issued April 28, 1857.

Claim.—"Elevating the orifice of injection above the base of the burner by means of a cone, or its equivalent, raised on said base, and into the chamber of the burner up into the distributor, or among its wires, in order that advantages may be attained."

Designs.

1. For *Iron Railings;* Robert Wood, Phliadelphia, Pennsylvania; dated April 7, 1857.

Claim.—"The form of all the parts."

2. For *the Plates of Stoves;* A. C. Barstow, Providence, Rhode Island; dated April 14, 1857.

Claim.—"The moulding and ornamental raised figures."

3. For *Clock Cases;* Elias Ingraham, Bristol, Connecticut; dated April 14, 1857.

Claim.—"The case, with a wood circular sash to the dial, in combination with the square top case. Also, the carved enrichment on the glass of the tablet."

4. For *Clock Case Fronts;* Chauncey Jerome, New Haven, Connecticut; dated April 14, 1857.

Claim.—"The base pilasters on the jamb, posts, cap, plate, panel, pilasters, and door."

5. For *Plates of a Cooking Stove;* N. S. Vedder, Assignor to Smith & Sheldon, Troy, New York; dated April 14, 1857.

Claim.—"The design for the lower front plate, foot, and doors."

MAY 5.

1. For an *Improvement in Sewing Machines;* Bryan Atwater, Berlin, Conn.

"The arrangement by which I am enabled to keep the loop of the needle thread positively in position by guides alone without the necessity of introducing a looper or other device into the loop, or making the loop pass round a hook or fixed shuttle."

Claim.—"1st, The arrangement of guides for forming the loop from the slack of the needle thread, and directing the same by an external operation to a position for the needle to pass through it, consisting of a stationary guide piece, a stationary notched plate or edge, and two stationary guides arranged in proper relation to each other, and to the needle and the cloth, or other material to be sewed, and employed in connexion with a proper feeding movement of the cloth or material, and in combination with the said contrivance, the guide plate with its lip. 2d, Though I do not claim the dog, operating in connexion with an elastic foot piece on the face of the cloth, as in the machine of T. J. W. Robertson, to produce the feeding movement of the cloth, or other material to be sewed, I claim the attachment of the dog to a lever, arranged and operated upon by a wiper on the driving shaft to produce a quick or sudden feeding movement of the cloth or other material, which shall at the same time aid in throwing the loop in the path of the needle."

2. For an *Improvement in Screw Cutting Machines;* Wm. N. Adams, Olmsted, O.

Claim.—"The construction of the branched body, the disk, sliding fulcrums, levers, and adjustable releasing screw, combined in such a manner as to gauge the size of screw and depth of screw thread, and to release the screw as soon as cut to a determinate extent."

3. For an *Improvement in Stuffing Boxes;* N. R. Bates, City of New York.

Claim.—"The combination and arrangement of the plate with the wires surrounding it, and the screw-rods and nuts, for the purpose of compressing evenly around the piston the packing as it wears."

4. For an *Improvement in Looms for Weaving Pile Fabrics;* Erastus B. Bigelow, Boston, Massachusetts.

Claim.—"Operating the pile wires by a vibrating staff controlled by a parallel motion. Also, the method of constructing and organizing the hook and carrier for operating the pile wires. Also, in combination with the aforesaid hook and carrier, a box or holder for holding the pile wires in position, and suitably guiding said hook to act thereon."

5. For an *Improved Machine for Cutting Veneers;* Gilbert Bishop, City of N. York.

"The nature of my invention consists in so arranging the log and its carriage, the knife and its bearings and gearing, and the driving and feed machinery, that any sized log may be cut, and the position of the log easily adapted and changed as required, to the grain of the wood, and giving to the knife a long continuous rectilinear cut or draw, presenting a new edge to the wood so as to cut the veneers smoothly, and uniformly clear through the log, and in sharpening and giving a fresh edge to the knife by its own movement at each stroke or cut of the knife."

Claim.—"1st, The arrangement of the knife suspended between the upright frame pieces, and at right angles to the log, and giving it a long continuous drawing cut across the log, whatever may be the width of the log by means of screws. 2d, The horizontal grooved and slotted plate or knife bed attached to the sliding plates, held and guided between the uprights above named, and carrying, supporting, and strengthening the knife in its whole length, and at the same time allowing it a vertical movement for feeding it to the log as required. 3d, The arrangement of shaft, the ratchet wheel, the slotted burr, and connecting rod, the vibrating bent lever and star wheel, operating and connecting together for the purpose of giving motion to the feed screws."

6. For an *Improved Adjustable Pole for Carriages;* Sherlock H. Bishop, Orange, Connecticut.

"My improvement consists in constructing the braces of the pole with joints, and the arch piece with slots, and securing the braces to the arch-piece by double adjustable attachments."

Claim.—"The method of adjusting the braces by means of the joints, slots, and eye-bolts, when the whole is constructed, arranged, and made to operate."

7. For an *Improvement in Boats for Duck Shooting;* Robert Bogle, Rock Hall, Md.

Claim.—"In combination with the hull, the openings therein and leggings attached, so that the gunner may propel his boat."

8. For an *Improvement in the Picker Motion for Looms;* Samuel Boorn, Lowell, Massachusetts.

Claim.—"Arranging the centralizer and its mortise, with the picker staff and its rocker, so as to operate therewith."

9. For an *Improvement in Machines for Printing Subscribers' Names on Newspapers;* Stephen D. Carpenter, Madison, Wisconsin.

"The nature of my invention consists in a compound cylinder on which the type for printing the names of subscribers is placed, the cylinder having a sliding and revolving movement for bringing the name required directly under the press or platen."

Claim.—"1st, The construction of the cylinder made in sections with the flanches, to which india-rubber or any flexible material is secured for receiving the type, which type are set on the face of the cylinder in columns. 2d, The said cylinder, in combination with the platen. 3d, The combination of said cylinder with the devices, whereby it is rotated."

10. For an *Improvement in Surgical Splint Apparatus;* J. H. H. and Wm. J. Burge, Brooklyn, New York.

Claim.—"The combination of the pad straps with the platform and rod, which combination is intended to confine the counter extending pressure as much as possible to the tuberosities of the Ischia. Also, the rod as a means of supporting the fractured limb, only in connexion with the employment of extension and counter-extension."

11. For an *Improvement in Swells for Melodeons, &c.;* Jeremiah Carhart, City of New York.

"This improvement consists in providing the 'swell' of a melodeon, or other instrument of similar character, with one or more valves, which can be opened when the 'swell' is closed for the purpose of graduating the tone of the whole or any portion of the instrument. It further consists in certain mechanical means of operating the said valve, by which it can be opened and closed, either while the swell is closed or while it is opened."

Claim.—"1st, Providing the swell with a number of holes, and fitting the same with a valve or valves, for the purpose of graduating the tone of a portion or the whole of the instrument when the swell is closed. 2d, The mechanism for operating the swell valve either while the swell is open or closed, consisting of the upright shaft with its lever and arm, and the flexible rod."

12. For an *Improvement in Nut Machines;* Richard H. Cole, St. Louis, Missouri.

Claim.—"The application of the spring to the sliding punch plates."

13. For an *Improved Vault Cover;* John B. Cornell, City of New York.

Claim.—"Arranging the respective glasses or tiers of glasses in an illuminating vault cover in inclined positions to be the straight base of said cover."

14. For an *Improvement in Vault Covers;* John B. Cornell, City of New York.

Claim.—"Combining a series of gutters with the under surface of an illuminating vault cover."

15. For an *Improvement in Metal Packed Pistons for Steam Engines;* George W. Cotton, St. Louis, Missouri.

"My improvement has reference to that class of piston heads in which a single split or divided metallic ring is made to form the packing."

Claim.—"The arrangement for operating together on a single ring packing, of the wedge with its sliding block and radial stretchers, spiral springs, and inner sliding steps or blocks. Also, forming the joint or break of the single ring packing, with overlapping tongues and wedge of less depth than the packing and fitting loosely between the beveled ends of the packing and the tongues, at the top and bottom, or opposite edges of the packing ring."

16. For an *Improved Portable Field Fence;* Ezra Cole, Fairhaven, Michigan.

Claim.—"The post for use in connexion with picket or panel sections of a fence, formed of two thin planks, one of said planks being arranged on the one side of a transverse sill, and the other on the opposite side of the same, and one bearing, when the sections are locked together against the inner face of one of the sections, and the other against the outer face of the adjoining section."

17. For an *Improved Method of Opening and Closing Gates by approaching Vehicles;* Solomon Cole, Rochester, New York.

Claim.—"The arrangement of levers and ways or rails and tilting pins, whereby the gate is not only opened and kept open, but the tilting pins on the other side of the gate are placed in the proper position to tilt the rails and close the gate on the passage of a vehicle."

18. For an *Improvement in Rotary Brick Machines;* George Crangle, Philadelphia, Pennsylvania.

Claim.—"A cylinder without movable bottoms to the moulds, in combination with a bed-piece fixed to the frame of the machine, so as to serve the purpose of said bottoms, the said cylinder and bed-piece being constructed, arranged, combined, and operated together."

19. For an *Improved Door Bolt;* Jeremiah M. Crosby, Norwalk, Ohio.

Claim.—"The arrangement of the bolt rod and the cam or eccentric."

20. For an *Improvement in Reaping and Mowing Machines;* Charles Crook, New Hope, Pennsylvania.

"The nature of my invention consists in employing an adjustable pinion between and in combination with the teeth of the internally geared driving wheel, and the teeth of a spur-wheel on the axle of the driving-wheel, whereby the machine can be quickly geared so as to be adapted either for mowing grass or cutting grain."

Claim.—"Operating the cutters of combined reaping and mowing machines by means of the intermediate pinion, in combination with the internally geared driving-wheel, and the spur-wheel on the driving-wheel shaft, when the same are constructed and arranged in relation to each other."

21. For an *Improved Omnibus Coffer;* Joseph T. Curtis, City of New York.

Claim.—"The application and employment of a movable transmitting coffer, in combination with omnibuses and other vehicles."

22. For an *Improvement in Straw Cutters;* E. G. Cushing, Dryden, New York.

"My invention consists in giving the box to which the 'leger' blade or cutter is attached, and within which the feed rollers are placed, a vibratory movement, whereby a greater cutting angle and also a longer stroke is obtained, and the straw or stalks held or grasped firmly in position, while being acted upon by the cutters, and a simple and adjustable feed motion also obtained."

Claim.—"1st, The disk wheel with cutter, one or more attached, in combination with the vibrating head or box in which the feed rollers are placed, and the 'leger' cutter attached, the above parts being arranged and operating conjointly. 2d, Operating the feed rollers by means of the ratchet wheel and pawl, when used in connexion with the vibrating head or box."

23. For an *Improvement in Heating Feed-water Apparatus for Locomotives;* Peter S. Ebbert, Chicago, Illinois.

Claim.—"In combination with the chamber enclosing the heating pipes, the inlet and exit pipes, so arranged as to cause the steam to circulate over, around, or through the heating pipes before it escapes."

24. For an *Improvement in Ice Cutting Attachments to Vessels;* Thomas Estlack, Philadelphia, Pennsylvania.

Claim.—"1st, The cutters formed of the teeth, and attached to the inclined bars, which are pivoted to the share. 2d, The share when applied and secured to the bow of the vessel by the chains, and used in connexion with the cutters."

25. For an *Improved Method of Uniting and Sustaining the Panels of Portable Field Fences;* Isaac D. Garlick, Lyons, New York.

Claim.—"My improved portable field fence."

26. For an *Improvement in Ploughs;* Thomas C. Garlington, La Fayette, Ala.

Claim.—"The combination of headed slide, strap, brace, and key, for performing the double function of bracing the beam and stock, and securing the mould board to the stock."

27. For an *Improvement in the Construction of Ploughs;* Jackson Gorham, Bairdstown, Georgia.

Claim.—"The foot piece having a box at its upper end, and the two flanches at its lower end, for the purpose of securing the foot piece to the beam, and the lower end of the brace to the foot piece."

28. For an *Improvement in Locomotive Engines;* Horace Gray, Boston, Mass.

Claim.—"Constructing locomotive steam engines with two or more boilers, or with one boiler having two or more separate fire boxes or furnaces connected."

29. For an *Improved Process for Purifying Gutta-Percha;* Robert Haering, City of New York.

Claim.—"The method of purifying gutta-percha by means of the ether and alkali."

30. For an *Improvement in means for directing the Exhaust of Locomotives;* Robert Hale, Roxbury, Massachusetts.

Claim.—"The device for the purpose of leading off a portion of the exhaust steam

to heat the feed-water, without interrupting or changing the direction of that portion of the exhaust not so employed."

31. For an *Improvement in Chain Pumps;* James Harrison, Jr., City of N. York.

Claim.—"The use, in combination with the buckets, of a lifting cord composed of coiled wire."

32. For a *Violin Attachment;* Andrew Hett, Augusta, Georgia.

"The nature of my invention consists in providing an ordinary violin with four additional strings, in such a manner as to vibrate all the sharp and flat tones."

Claim.—"The application of the vibrating strings to violins, violoncellos, and other similar instruments."

33. For an *Improved Adjustable Bed and Gauge to Regulate Tenoning;* D. Hodges, Suffolk, Virginia.

Claim.—"The reversible bed with adjustable end guide, stationary guide, and devices for securing the lumber."

34. For an *Improvement in Brick Machines;* Joseph W. Jayne, Sandusky, Ohio.

Claim.—"1st, The radial, sliding, and revolving charges, in combination with the eccentric slot or groove, and horizontal mould wheel. 2d, The combination of the peculiarly shaped yoke, with the mould wheel, and the sliding and revolving charges, the whole being constructed and operating conjointly."

35. For an *Improvement in Cotton Seed Planters;* Henry L. Justice and John H. Galbreath, Goodlettsville, Tennessee.

Claim.—"The combination of a rag-wheel having adjustable arms, with the movable hopper of a cotton seed planter."

36. For an *Improvement in Transmitting Motion;* Mathaus Kaefer, Alexandria, Pennsylvania.

Claim.—"Hanging a loaded fly or balance wheel on a traveling carriage, so that said carriage shall yield to the momentum of the fly-wheel, as it passes the dead points."

37. For an *Improvement in Machines for Cutting and Binding Grain;* Hiram Kellogg, McHenry, Illinois.

Claim.—"The compresser device formed of the grip rods, standard, and springs, in combination with striker."

38. For an *Improvement in Machines for Turning the Edges of Cloth;* John P. Marston, Charlestown, Massachusetts.

Claim.—"The combination of the guides and roller."

39. For an *Improvement in Pocket Safes and Fastenings;* George R. McIlroy, Covington, Kentucky.

Claim.—"Holding the shank of the button between the horizontal spring and the cam on the vertical spring, so that by drawing and letting go the rod, the said shank will be raised up by the horizontal spring, and the cam passing under it throw it out of the hasp part; and this I claim whether one, two, or more buttons be used, so long as the series is thrown out by one operation of the rod."

40. For an *Improved Self-Reversing Feed Motion for Sawing Mills;* Daniel and Angus A. Methven, Wooster, Ohio.

Claim.—"The arrangement of the inclined planes, the connecting rods, and rock shafts, the pawls, and the double ratchet-wheels, in combination with the double toothed saw."

41. For an *Improvement in Machinery for Napping Cloth;* John C. Miller, Starucca, Pennsylvania, and Charles N. Tyler, Washington, D. C.

Claim.—"1st, The combination and arrangement of two or more napping cylinders, 2d, The teazling disks, or their equivalents, in combination with the cylinders. 3d, The method of securing the gig rods to the cylinders."

42. For an *Improvement in Ships' Hawse Holes;* Robert R. Osgood, Assignor to Jason C. Osgood, Troy, New York.

Claim.—"Supporting a pulley on a rotating bed, and combining therewith a guide tube hinged on its axis for the rope to pass through."

43. For an *Improvement in Wrenches;* Charles Pinder, Lowell, Massachusetts.

Claim.—"Moving, holding, and releasing the movable jaw, by means of the double wedge or key, with its inclined planes operating against similar ones formed in the movable jaw, while the lower surface of this wedge comes in contact with the inclined plane in the groove formed in the wrench bar."

44. For an *Improvement in the Buckets of Automatic Weighing Machines;* Rufus Porter, Washington, D. C.

Claim.—"1st, The combination of the tripping rods with the valve plate and knuckle braces, whereby the movement of the valve gate (which is operated by means of the scale beams), causes the contents of the bucket to be discharged alternately. 2d, The knuckle braces, in combination with the trap doors, whereby the latter are spontaneously closed and fastened immediately after the grain is discharged."

45. For an *Improvement in Coupling for Shafting;* William and Coleman Sellers, Philadelphia, Pennsylvania.

Claim.—"The use of two conical sleeves within one external sleeve, when they are so arranged as to compress the ends of the coupled shafts separately, whether the shafts be of the same or different diameters. Also, bolting said conical sleeves together, or in any other mode whereby the bolts may serve as keys to prevent the internal cones from turning in the external sleeve."

46. For an *Improved Process for Preparing Green Sand Marl as a Fertilizer of Lands;* Charles Stearnes, City of New York.

Claim.—"Concentrating their fertilizing and stimulating properties by the previous separation of the useless matters of the marl, and disintegration of the green sand, and the superaddition of ammonia."

47. For an *Improved Piano-Forte Action;* Henry Steinway, City of New York.

Claim.—"The sliding post and spring, or its equivalent, applied in relation to the jack and key, to operate in combination with a block on the hammer shank."

48. For an *Improved Mode of Constructing Rollers or Cylinders for Printing Fabrics;* Richard F. Sturges, Birmingham, England; patented in England, October, 16, 1856.

Claim.—"Casting a thick tube of a hard and easily fusible metal or alloy in the interior of a tube of copper or alloy of copper."

49. For an *Improved Clothes Pounder;* Sardis Thompson, West Otis, Mass.

Claim.—"The bell-shaped cylinder, in combination with the piston, piston-rod, spring, and handle, or other equivalents, to produce the same effect, viz: the cleansing or washing clothes by agitating the liquid by the pressure of air."

50. For an *Improvement in "Ladies'" Skirts;* Helen C. Traphagen, City of New York.

Claim.—"The attachment of a series of air-tight tubes to the body of a skirt or petticoat, to expand and set out the skirt when the said tubes are filled with air."

51. For an *Improved Arrangement of Door Sill and Door Strip;* Henry Tryon Steuben, Pennsylvania.

Claim.—"The construction of my door strip in connexion with the sill, or any other construction substantially the same, and which will produce the same result."

52. For an *Improvement in Blind Fastenings;* Horace Vansands, Middletown, Conn.

Claim.—"The attaching of the blind hook by means of a screw or rivet between, and in the recess of the two shells or case."

53. For an *Improvement in Machines for Combing Wool;* Cullen Whipple, Providence, Rhode Island.

Claim.—"The combing machinery whereby the fibres after being fed into, or received amongst, teeth (set in a suitable surface), have their ends raised out from the teeth, and held by nippers, while the ends are cleaned—the cleaned ends of the fibres being then nipped and drawn among the teeth in order to clean the other ends, and also to separate this quantity of fibres from the other fibres amongst the teeth; the protruding ends are then deposited amidst the teeth in such manner that they overlap the ends of the

quantity of fibres which have been just previously similarly treated, thus admitting of the prepared or combed fibres being doffed or drawn off from the teeth in a continuous sliver."

54. For an *Improvement in Machines for Making India-Rubber Belting;* Robert Hale, Roxbury, Massachusetts.

Claim.—"The manufacture of machine belting by folding and cementing strips of india-rubber cloth by a series of mechanical devices. Also, the method of moistening the seam, and applying the india-rubber strips thereto. Also, the manner of applying the middle for a belt of three or more plys, by means of guides, the two being united."

55. For a *Varnish to Prepare Photographic Grounds for Wood Engravers;* Robert Price, Worcester, Massachusetts.

Claim.—"The varnish composed of asphaltum, varnish, lamp black, and ether, when the same is applied to the block by rubbing it into its pores."

56. For an *Improvement in Sleighs and Cutters;* Lewis B. Randall, Penn Yan, New York.

Claim.—"The parts designated by the letters."

57. For an *Improvement in Fire Arms;* John B. Read, Tuscaloosa, Alabama.

Claim.—"The providing the upper part of the powder space or chamber of fire arms with angular or wedge-shaped projections, to be forced into the rear of the projectile in the act of loading. Also, the form of ball cylindrical at or near its middle portion, with a slight excavation or recess in the inner and under side of cylindrical part, both ends of ball to be conoidal or conical."

58. For an *Improved Arrangement of Stair Steps;* Charles Robinson, Cambridgeport, Massachusetts.

Claim.—"Placing beneath each step a spring or springs, so as to give an elastic movement thereto in ascending and descending upon the stairs."

59. For an *Improvement in Close or Open Stoves;* Henry Seitz, St. Mary's, Va.

Claim.—"The arrangement in a grate, of the plates, supplementary grate bars, dust flue, air heating chambers, and passages."

60. For an *Improvement in Locks;* Alfred Williams and Edward P. Cummings, Philadelphia, Pennsylvania.

Claim.—"The use of the yoke, the levers, and the stop lever, the whole constructed, arranged, and operating in connexion with the disk."

61. For an *Improved Mode of Operating the Gate of Turbine Wheels;* L. M. Wright, Niagara Falls, New York.

Claim.—"I do not claim the parts separately, but their arrangement."

62. For an *Improved Mode of Securing Hubs to Axles;* Leonard J. Worden, Utica, New York.

"The object which I have in view in this invention, is to provide a fastening at the front or outer end of the skane, in which the skane and nut may be cast of a simple form to fit each other with as little fitting up as possible."

Claim.—"Making on the front end of the skane or bush, a neck of peculiar form, that is to say, having two or more parts of its periphery of a cylindrical shape, whilst the remaining parts are both cam-shaped and conical, when used in connexion with a nut whose internal periphery corresponds with the external periphery of the neck lock plate, or its equivalent."

63. For an *Improvement in Brick Machines;* James Hotchkiss and Wm. H. Schofield, Assignors to selves and Wm. R. King, Yellow Springs, Ohio.

Claim.—"The combination of the plungers with the sliding carriers and mould wheel, when the same are so constructed and arranged as to operate in relation to each other."

64. For an *Improved Cutter for Turning Cylindrical Wooden Boxes;* Henry Mellish, Walpole, New Hampshire, Assignor to Charles Pope, Brookline, Mass.

Claim.—"The cutting tools made with cutters or cutting edges, to cut and plane the box or box cover."

MECHANICS, PHYSICS, AND CHEMISTRY.

*The Photo-Galvanographic Process of Engraving.**

Light and electricity have been put into harness by Mr. Paul Pretsch, lately the manager of the Imperial Austrian Printing Office at Vienna, and trained to perform the united functions of the artist-draftsman and engraver.

The first steps of this photo-galvanographic process are similar to those adapted to the glass-plate photographer. The operator coats a glass plate with a gelatinous solution, suitably prepared with chemical ingredients sensitive to light. These compounds form the coating material, which is allowed to dry upon the glass or other plate which is coated with it. When dry, the coated plate is exposed to the light in a copying frame, in contact with the print or drawing which is to be copied. After exposure, the plate exhibits a faint picture on the smooth surface of the sensitive coating, and it is washed with certain solutions, when the whole image comes out in relief, whilst the tints of the original are still maintained. When sufficiently developed, this relievo plate is dried and moulded. The mould is prepared for electric conduction, placed in the electrotype battery, producing a thin copper-plate or matrix, which is used for producing finally the intaglio printing plate.

With this printing process there is no fear of fading, as the plate impressions are in ink, and the attention of an ordinary printer suffices to keep the pictures to the proper color.

We have seen some remarkable specimens, especially from Gothic buildings, and look for great things from the process. The Company, amongst other works, propose to publish, from photographic originals "The Cathedral Antiquities of the British Empire;"—the plates to be engraved by the Company's patent process, on a scale of great magnificence.

Wrought Iron Beams and Joists.† By W. Fairbairn, F. R. S., C. E.

Abstract of Report to the Board of Trade, on the Paris Universal Exhibition.

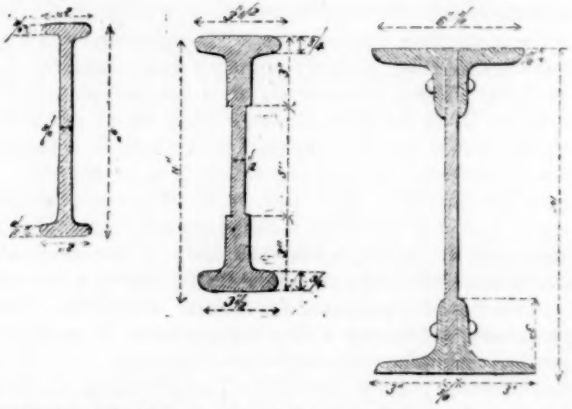
In the manufacture of wrought iron beams and joists the French have taken an undoubted lead; and the specimens exhibited from the Forge et Fonderie de Montataire and others, at the late Paris Universal Exhibition, indicated a degree of perfection which has not as yet been attained in this country. Some of the joists, of the sectional dimensions shown in the annexed sketch (fig. 1), were rolled 60 feet long, and another specimen of still greater dimensions, as at fig. 2, was rolled 40 feet long. These specimens, and several others of different sizes, showed how much has been done, and how much may yet be accomplished in this branch of manufacture; and we have yet to learn why the same facilities cannot be afforded for the introduction of this class of work direct from rolls by the iron makers of England and Scotland. If this description of beams were properly rolled and manufactured, it would effect a great saving in mechanical construction, and would, at the same

* From the London Builder, No. 728.

† From the Lond. Civ. Eng. and Arch. Journ., March, 1857.

time, produce much greater certainty in the strength of beams, by dispensing with the present system of joints, and the riveted angle-iron, which constitute at the present moment our defective mode of constructions, as shown in the section, (fig. 3.) It would introduce also into our present system of manufacture, a new and greatly enlarged branch of industry, adapted to all the requirements of the architect, the builder, and the engineer.

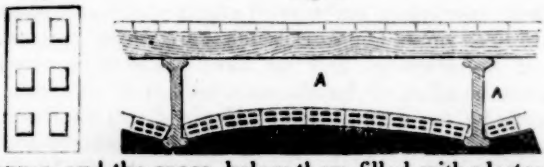
Fig. 1. Fig. 2. Fig. 3.



The introduction of this new description of beam, if properly prepared, would establish a new and important era in the history of constructive science, as it would supply architects and engineers with an article on which they might safely depend for durability and power of resistance to strain; which would not be liable to dry-rot, sap, or any of the destructive diseases to which timber is subject; and which would be free from oxidation when kept dry and imbedded in plaster. This is shown by the construction of floors, in constant use in Paris. Besides, a building so constructed possesses the advantages of being fire-proof, strong, and secure.

It may here be stated, that the floors of all the better class of houses in Paris are now built with iron joists, placed at distances varying from 2 feet to 2 ft. 6 ins. asunder. Some of these floors supported on iron joists are 30 feet wide. At about every 3 ft. 6 ins. cross tie rods are placed, on which rest slender wrought iron rods ½-inch square, three between each joist; these rods are run through perforated bricks of the annexed sectional form (fig. 4). These bricks are built in a slightly

Fig. 4. Fig. 5.



arched manner, and the space below them filled with plaster, forming a perfectly solid floor. Across these rods and arches, wooden sleepers are placed to receive the boarding for the floors, leaving a hollow space be-

tween each joist, as at A, A, (fig. 5.) In this description of floors there is every security from fire, and the plaster being a bad conductor of heat, equalizes the temperature of the room. The only objection, is the open space A, A, (fig. 5,) between the arches and the boarding, serving as a receptacle for vermin. This objection might be removed by divisions of plaster 6 inches thick carried across the floor, and in contact with the boards. This description of building is in general use in Paris and most other towns of France, and viewing it as a permanent fire-proof structure, I should earnestly recommend its adoption in this country.

In the manufacture of malleable iron beams in France, sufficient attention has not been paid to form, in order to attain the section of greatest strength. The French philosophers and engineers are fully aware of the experiments made in the year 1845, for investigating the strength and form of iron beams, in order to establish the principle on which the Britannia and Conway tubular bridges should be constructed.

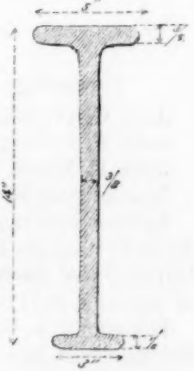
The formulæ deduced from these experiments are well known in France, and up to the present time have been used for similar constructions. They proved that wrought iron beams followed a totally different law in their resistance to strain, to cast iron; that in wrought iron beams the area of the bottom flange requires to be little more than one-half that of the top; while in cast iron beams the area of the bottom flange should be *six* times that of the top flange. This difference arises from the great resistance which wrought iron offers to a tensile strain, and its comparatively inferior resistance to compression. Cast iron, on the other hand, possesses a high power of resistance to compression and defective resistance to tension.

The following table of resistances will show how the material should be distributed, in order to obtain the maximum of strength with the minimum or least required quantity of material:

The resisting power of—

	To tension, in tons.	To compression, in tons.
Wrought iron plates is	23	12
Copper,	16	3
Cast iron,	8	51

Fig. 6.



From the above it is evident, that to obtain the maximum strength in a wrought iron beam from the least quantity of material, the area of the top flange should be nearly double that of the bottom; but as this is difficult in practice, I submit the annexed form (fig. 6), as the nearest approach to a maximum sectional strength. It is desirable to make the top flange as broad as possible, for the purpose of giving the beam lateral strength, and in this form the useless material now given to the bottom flange would be saved.

In other descriptions of manufacture, such as railway bars, angle iron, T-iron, and other varieties, we are in advance of other nations, though in beams and joists, like those so extensively used in France, we are far from perfect.

*Solution of Quartz.**

The Australian papers just received from Melbourne report the discovery, by Count Dembinski, of a process by which quartz or silica is chemically dissolved, and all the gold, metallic oxides, and metals contained in it precipitated. His method is the following:—One part of quartz in small pieces is, together with two-and-a-half or three parts of carbonate of soda, brought to a red heat and melted. Cast iron tubes are, perhaps, the best vessels in which this process can be done. Silicate of soda is now formed, deliquescent in air, and perfectly soluble in cold water, the carbonic acid of the soda being, of course, given off by the reaction. This silicate of soda is dissolved in water, in wooden vessels, and thus left for a few hours, during which time the gold and all other foreign substances contained in the quartz are precipitated. After the precipitate has been formed, the solution of silicate of soda is, by means of a syphon, decanted into another wooden vessel, in which, by the inflation of carbonic acid, the soda is separated from the silicic acid, and regained as carbonate of soda. By decanting it again, and evaporating the water, it is made fit for another dissolving process. He obtains the carbonic acid, which is used for regenerating the soda, from the same fire which he makes use of in combining the quartz and soda. This he does by employing the well known centrifugal air-pump, and follows up in all particulars the method of Melsens in the decomposing of saccharate of lime. By inflating carbonic acid into the solution of silicate of soda, he separates the silicic acid from the soda. This latter remains in water, the silicic acid has been precipitated in the form of a transparent, nebulous, jelly-like substance, which cannot be separated from water by filtration. He now decants the solution of carbonate of soda, which, by means of evaporation, he obtains again as dry carbonate of soda. As such it can be made use of in further operations.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, June 18, 1857.

John C. Cresson, President, in the chair.

John F. Frazer, Treasurer.

John P. Murta, Recording Secretary, pro tem.

The minutes of the last meeting were read and approved.

Letters were read from the K. K. Geologischen Reichsanstalt, Vienna, Austria; Charles F. Loosey, Esq., City of New York; Regents of the University of the State of New York, Albany, N. Y.; and the Academy of Science, St. Louis, Missouri.

Donations to the Library were received from the K. K. Geologischen Reichsanstalt, and Alois Auer, Esq., Director of the Imperial Printing Department of Austria; the Osterreichischen Ingenieur-Vereines, and the Niederosterreichischen Gewerbe-Vereines, Vienna, Austria; The Mechanics' Institute of Tennessee, Nashville; The Metropolitan Mechanics' Institute, Washington, D. C.; The American Philosophical Society; The

* From the Lond. Mech. Mag., Jan., 1857.

Sunbury and Erie Railroad Co.; The Pennsylvania Institute: and Messrs. Ellwood Morris, Isaac S. Williams, and Wm. H. Jones, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statement for the month of May was read.

The Board of Managers and Standing Committees reported their minutes.

The Board of Managers reported that they had elected Alois Auer, Esq., Director of the Imperial Printing Department of Austria, a corresponding member of the Institute.

Candidates for membership in the Institute (3) were proposed, and those proposed at the last meeting (3) were duly elected members.

It was announced that the President and the Recording Secretary of the Institute had been elected corresponding members of the K. K. Geologischen Reichsanstalt, in Vienna, Austria; when

On motion of Prof. Frazer, the Corresponding Secretary was instructed to return the thanks of the Institute to the K. K. Geologischen Reichsanstalt of Vienna, Austria, for electing the President and the Recording Secretary of the Institute, corresponding members of their Association.

A fork made of aluminum was exhibited to the meeting, which, having been left for a month in a jar of pickled walnuts, had lost the entire portion which had been immersed, and was much corroded in the other portions.

A piece of the cable intended for the Atlantic Telegraph was shown to the members. The conducting wires are of copper, seven in number, one being in the centre, with the others disposed around it radially, all being in contact; these are insulated by a coating of gutta percha, which is served, or closely wrapped, by tarred spun yarn, which is enveloped by eighteen strands, each composed of seven wires loosely twisted. These outer strands are intended to take the strains that may occur in the laying, or after, due to the weight of the cable itself, or the action of currents. About six miles of the cable will have the strands made of steel wire, of a strength competent to sustain about six tons; and will be the part laid first, as the greatest strains are naturally expected at the time when the cable is stretched in a comparatively horizontal line between the two receding vessels employed to lay it.

Mr. Richard L. Smith presented to the meeting his patent improvement in car brakes. This improvement consists in the employment of sliding rods situated below the axles, and extending the whole length of the car. The sliding rods are connected to bars passing between rollers on shafts, which have their bearings in hangers attached to the rubbers, which act on the top of the wheels. The bars which pass between the rollers are furnished with inclined planes, so arranged, that, on the said bars being pushed in one direction or the other by means of the sliding rods, the inclined planes will act on the lower rollers, and cause the rubbers to bear hard upon the wheels. The sliding rods are so connected to each other and to the brake bars, that they in nowise interfere with the motions of the trucks.

In order to operate the sliding rods of each car of the train suddenly to avoid collision, there is hung in front of the brake van or tender a lever with two arms, one having a pointed projection, and the other a

roller so arranged, that the lever may be depressed, and the pointed projection brought in contact with the ground, when the arms will, through the momentum of the cars, be suddenly driven back, until the projecting point is forced from contact with the ground by the action of the roller on the arm as a fulcrum. This movement of the arm, which is modified by a spring, is communicated by means of a rod to the sliding rods of the car, and so on through the whole train of cars simultaneously, thereby pressing the rubbers against the respective wheels.

In order to regulate the amount of movement of the jointed sliding bars, when the train is required to make an ordinary stoppage, or to prevent any movement whatever of the said rods, when the train descends an inclined plane, there is placed underneath the floor of the tender or brake van a bumper rod, which is so arranged that its end may be brought nearer to, or farther from, the bumper of the first car at pleasure. As the rubbers and brakes are supported directly by the axle, they do not in the least interfere with the action of the car springs, thus avoiding the unpleasant jarring so much felt from brakes in common use.

The subject of *the Joints of Railway Tracks*, coming up in order, pursuant to notice given at the last monthly meeting, the discussion was commenced by Ellwood Morris, C. E., who remarked :—

That notwithstanding the vast extension of railways, and the great improvements made in their rolling machinery, but little has been done for the track, and the plan of the "*permanent way*" (so-called,) has remained substantially the same for twenty years or more, though *now* in the process of modification, by many skilful engineers.

A great difficulty has always existed in forming the joints or connexions between the independent bars of iron, of which the tracks of railways are composed, and notwithstanding the very numerous plans proposed or tried for joints (several hundreds in number), we may truly say that no single plan of joint has yet commanded the general approbation of railroad men.

The joints of railways still form perhaps the most imperfect part of railway superstructure, and the selection of the best practical joint, under all the circumstances—a problem of great importance to railroads, —*yet remains a desideratum.*

To this subject we wish to draw your attention, and with the view of opening the discussion, *twenty-one* of the leading joints will now be referred to, and in such brief reference, many meritorious plans will necessarily be overlooked ; but it is to be hoped some of the members present may assist in the explanation, by bringing forward such others as they may think of use.

Notice of some of the Principal Joints.

1. *Cast Iron Chair by George Stephenson, C. E.*, (1829,) on stone blocks, rail secured by wrought iron wedge.*

2. *Cast Iron Chair of Robert Stephenson, C. E.*, on stone blocks, and upon wooden cross-ties, rail secured by a pin keyed through the chair.*

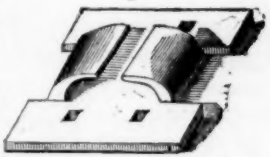
3. *Cast Iron Chair with wooden key*, first used by J. Locke, C. E., on the Grand Junction Railway,* and very generally adopted since.

* English Patents. Wood on Railroads. Breese's Railway Practice, &c.

4. *Norris's Cast Iron Chair*, (England,) cast upon the joints in place by means of a traveling cupola. This form of chair, which seems to negative all idea of expansion and contraction, is said to answer very well in some cases.*

5. *American Wrought Iron Chairs*, commonly used in the United States, weighing from 7 to 10 lbs. each—being about 7 inches square on base, and $\frac{1}{2}$ to $\frac{3}{4}$-inch in thickness—the $\frac{1}{2}$ inch chair having proved too light. The $\frac{1}{2}$ inch chairs weigh 7 lbs., and the $\frac{3}{4}$-inch chairs 10 lbs. each. (See Fig. 1.)

Fig 1.



6. *Davis's Cast Iron Chair*, (figs. 2, 3, & 4,) with elastic seat. This is an open sided chair, with a flat piece of indian rubber placed under the joint, and kept in place by a wrought iron plate with the edges turned down. It is in successful use on some of the New England railroads, and is said to make a good joint—but certainly a yielding one.

Description of Figs. 2, 3, 4.—Fig. 2 shows the chair *a*, ready to receive the rail, which is to be notched on one side only—*c* being the boiler plate cap, over the rubber bearing. A plate of india rubber, *h*, $\frac{1}{4}$ inch thick, lies on the bottom of the chair, *o*, as shown in fig. 4, and is covered and confined by the wrought iron plate, with the ends turned down, as shown at *c*, figs. 2 and 3.

Fig. 2.

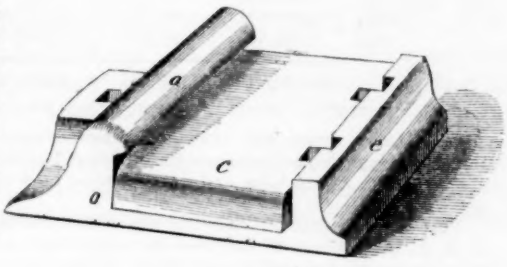


Fig. 3.

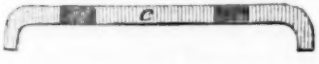


Fig. 4.

7. *Morley's divided Cast Iron Chair*, (figs. 5 and 6,) in two parts, connected by bolts under the rail. This is a recent invention, in the right direction.

Fig. 5.

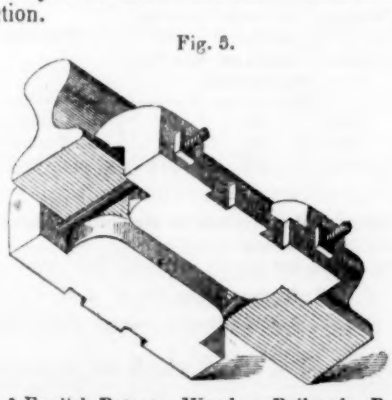
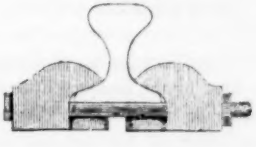


Fig. 6.



* English Patents. Wood on Railroads. Breese's Railway Practice, &c.

8. *Hewson's Cast Iron Chair*, (33½ lbs. weight,) of the kind used for 60 lb. rails, upon the Upper Schuylkill railroads. This is a close chair without keys, made to fit the base of the rail, and is crossed at the centre by a parting rod ½-inch square, against which the rail rests, and which keeps the rails in place longitudinally.

The following communication from Col. Hewson will show the wear of cast iron chairs in use.

TABLE—*Showing the number of Cast Iron Chairs renewed on the Reading Railroad from* 1849 *to* 1855 *inclusive, compiled from their Annual Reports:*

Year.	Tons of coal freight and passengers.	Tons of materials for use of road.	Total tons carried.	Number of chairs renewed.
1849	1,281,061	145,503	1,429,564	26,537
1850	1,586,230	157,450	1,743,680	27,292
1851	1,925,401	219,731	2,145,132	26,286
1852	1,940,954	181,217	2,122,171	19,742
1853	1,902,036	174,161	2,076,197	13,448
1854	2,394,972	187,591	2,582,563	13,385
1855	2,662,189	247,478	2,909,667	36,544
	13,695,843	1,313,131	15,008,974	163,234

As it is very seldom that chairs are renewed upon the sidings, I have estimated 106,400 upon the main tracks assumed at 200 miles, and 532 chairs to the mile, including branch to Philadelphia and tracks leading to wharves at Richmond, we find the following results—

That in the passage of 13,695,843 tons of 2000 lbs. upon the main tracks of the P. & R. R. R., 153 per cent. of their cast iron chairs have been replaced—at the rate of 22 per cent. per annum—and that 8,000,000 *of tons have destroyed the entire number of cast iron* joint fastenings on their main tracks.

This destruction by tonnage is fully confirmed by the experience of the roads under my charge, the record of which is shown in the following table—

STATEMENT—*Of the number of broken cast iron chairs for* 60 *lbs. rail replaced on the main tracks of the Port Carbon, Mill Creek and Schuylkill Valley Railroads, from January* 1*st*, 1853, *to December* 31*st*, 1856.

Name of road.	Tons of coal and freight 2240 lbs. to the ton from 1853to1856.	Number of chairs broken.	Per centage of whole number of chairs on main tracks.	Per cent'ge per annum.	Remarks.
Port Carbon R. R.	2,596,353	1233	44	11	563 chairs estimated to each mile of main track.
Mill Creek, "	2,087,267	1088	32	8	
Schuylkill Valley "	1,933,804	2172	30	7½	

Note.—That the Port Carbon Railroad is the terminus for the entire locomotive force used by the Reading Railroad in the transportation of coal.

The running of which, upon their tracks, has greatly increased their depreciation.

F. HEWSON, *Eng. Mt. C. & Pt. C.,*
Mill Creek & Schuyl. Valley Railroads.

Pottsville, June 11*th*, 1857.

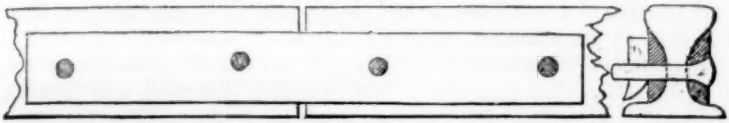
The above 8 examples, and a host of others which we have not room

even to notice, are of the nature of "*supported joints*," in which the chairs carry the ends of adjacent rails, and are themselves sustained upon a single cross-tie.

The following *thirteen* kinds of joint fastening, are all of the nature of "*Fished Joints*," to the use of which in some form all modern experience upon railroads *most strongly tends.*

9. *Wrought Iron Splice*, or "*American Fish Joint*," invented in 1843 by Robert H. Barr, of New Castle, Delaware, put in use upon the New Castle and Frenchtown Railroad, and model deposited in the Franklin Institute, Philadelphia, Nov. 1843. This is the identical "*Fish Joint*," re-invented in 1848 by W. B. Adams, used upon the Eastern Counties Railroad, England, in 1849, and forming at the present moment the most approved railroad joint in England, and we may say in Canada (fig. 7).

Fig. 7.

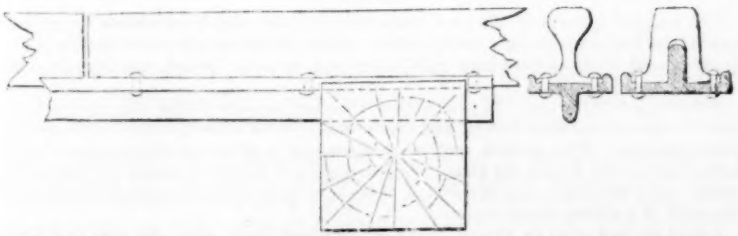


10. *English Fish Plates* of W. B. Adams, (1848.) These are identical with Barr's (1843,) except that Adams' fishes are hollow next the rail, do not fit it tightly, and are secured by screw bolts instead of key-bolts, which last is no improvement.*

11. *Smith's* T *Under-splice of* T *Rail*, patented by Charles E. Smith, of Philadelphia, consists of an under-plate with a rib projecting downwards, and embraced by notches in the cross-ties, while secured by rivets to the rails—this splice is also used with the U rail, (fig. 8.)

12. *Smith's* T *Under-splice of* U *Rail, used upon the Pennsylvania Railroad*, riveted to the base of the rail, and having a rib projecting upwards into the hollow of the U, which completely secures the joint laterally as well as vertically.

Fig. 8.



13. *Under-plate of the Mad River Railroad*, (Ohio.) This is merely a long plate about $\frac{3}{8}$ths of an inch thick, with raised edges or lips, between which the rail sets, and the whole being fastened down together to the cross-ties by the ordinary hook-headed spike in notches.

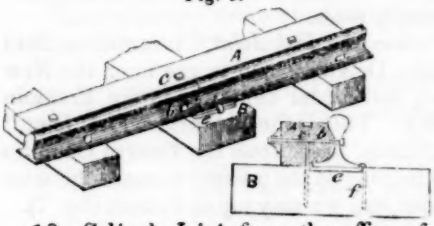
14. *Barr's American Fish Joint, as modified and used upon the Pennsylvania R.R., by Edward Miller, C. E.*, which has proved an excellent joint. The only difference between it and Barr's is, that a small hori-

* Clark's Railway Machinery, page 285.

zontal ledge or shoulder, is rolled upon the rails top and bottom, so as to give a firm seat to the rectangular fish pieces, bolted to the sides.

15. *Trimble's Wooden Splice*, (fig. 9.) This is applied outside of the rail, fitting its hollow, and extending over three cross-ties, to which it is bolted vertically by long spikes, and secured to the rails horizontally by four screw bolts, while under the joint a piece of iron plate is put. This makes a very good joint, and has received the approbation of some of our best civil engineers. It is sometimes used *double*.

Fig. 9.



16. *Spliced Joint*, from the office of the Pennsylvania Railroad Co. This consists of a combination of Trimble's splice on one side, and Barr's fish plate on the other.

17. *Steele's Combined Joint*, (fig. 10,) now used extensively upon the Reading Railroad, and forming a very good joint. This consists of Trimble's wooden splice outside, Barr's fish plate inside, and the Mad River under-plate underneath rails, and covering the joint, both under-plate and rails being notched for the spikes.

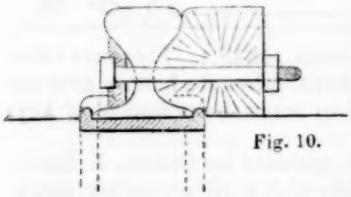


Fig. 10.

18. *Hewson's Long Wrought Iron Chair.* This is an extension of the ordinary American wrought iron chair, so as to carry a joint *between two ties;* it acts in part as a splice, and has the ½-inch parting rod in the centre, separating the rails, which is a distinguishing feature in Col. Hewson's chairs, and enables the rails to be used just as they come from the rolling mill, without boring or notching. This joint is now under trial upon the Upper Schuylkill railroads. Col. Hewson says:—

The original patterns of the long wrought iron chair were ¼-inch thick, 26 inches in length, and 7 inches sill plate, giving on sills 7 inches broad, a space of 12 inches between bearings—50 of these have been laid down and severely tested, and three have been renewed in ten months.

300 chairs 5-16ths inch thick, similar in all other respects to the one described, have been in use for the same period, and also severely tested with no unfavorable results—*none removed.* The pattern sent to the *Franklin Institute*, 5-16ths inches thick, 22 inches long, with 5 inch sill plate, will give a span 8 inches between bearings, which greatly increased their rigidity—500 of these have been laid—have given no indications whatever of yielding—*none removed.*

I have no hesitation in saying that a chair ⅜-inch thick after the size and pattern sent to the Institute, will furnish a redundancy of strength. The Reading Railroad wrought iron chair or under-plate is ⅜-inch thick, 32 inches in length, which upon sills of seven inches, will give a space of 18 inches between bearings.

My chair ⅜-inch thick will have but a space of 8 inches. I think it is better to shorten the chair than to increase its thickness and length, as the track is kept up better.

Placing the joint sills a few inches nearer, will not increase the number of sills to the bar.

The wrought iron chair sent to the Institute will *average* 16 2-10 lbs., 5-16 thick. I have paid 5 cents per pound taking a small quantity; they objected at the mills to furnishing it for less, as they were obliged to alter their rolls.

The cost in unloading, marking off the holes, turning, punching, and fuel, stood at 8 cents each.

This will make the cost per chair, 5-16 thick, as follows:—

16 2-10th lbs. at 5 cents,	81 cts.
Labor and fuel in turning,	8 "
Total,	89 "
The short cast iron chair for 60 lbs. rail, weighs 33½ lbs. at 2¾ cents,	92 "
Difference in favor of long wrought iron chair,	3 "

The Reading Railroad Company pay $75·00 per ton for their wrought iron underplates, which is at the rate of 3⅜ cents per lb. I can doubtless contract for the plates at $90 per ton, which will include the punching; this is at the rate of 4 cents per lb.

The cost of a ¾-inch chair will then be as follows:—

18½ lbs. at 4 cents,	74 cts.
Labor and turning, including fuel,	4 "
Total,	78 "

This is 14 cents less than the cast iron chair.

Note.—That the iron should be cross piled at the mill, for it will break when bent with the grain. Different qualities of iron will also require different degrees of heat in turning.

For a simple heating oven without a blast, I prefer a medium between the red and cold short.

The plates when punched are turned at a proper heat by a hand press. The cost for constructing will not exceed one hundred dollars.

I have observed that the end of the rail against the trade receives the hardest usage; thus on the down track of our roads, the northern ends of the bars are more battered, while on the up track the southern ends show the same symptoms. In laying track to strengthen the joints upon a continuous bearing chair, I place the broadest sill against the line of trade, or on that side towards which the heaviest traffic moves.

Pottsville, June 13, 1857. F. Hewson, *Civil Engineer.*

19. *American Fish Plates modified by Ellwood Morris, C. E.* In this joint greater strength is sought to be given to the fish plates, by turning them under the base of the rail. The *fish plates* are to be secured by four key-bolts, and bedded or let down about ¾ths of an inch into the cross-ties, so as to keep them in their proper position even if the bolts fail. The whole to be secured to the cross-ties by the usual hook spikes. This splice is under consideration by a Committee of the Institute, whose report will be made public in due course.*

20. *Compound Rails* of all forms act as fish plates, and make excellent joints, and those with *a solid head*, as used upon the New York Central Railroad, answer a very good purpose in every way.

21. *The Ring Joint of the Camden and Amboy Railroad* (fig. 11).—This

* A difficulty arises in practice from the original form of the fish joint, (fig. 7,) in consequence of the fish plates on the sides of the rails, resting both at top and bottom upon inclined planes, which under the leverage produced by the rolling action of the wheels, become powerful wedges to *break* or to *unhead* the bolts. Late information from England (Colburn and Sanborn, May, 1857,) describes this difficulty of loosening and breakage of bolts as being so serious as to be likely to cause the entire abandonment of "*fish jointing*" in its original form, and it has been already proposed (W. B. Adams,) to stamp the ends of the rails while hot, into square shouldered seats or recesses, for the fish plates.

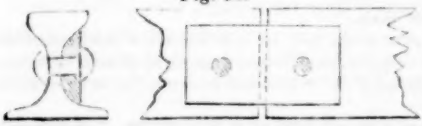
This great practical difficulty is entirely obviated by the square shoulders devised by Edward Miller, C. E., to receive the fishes, or by lapping or turning the fish plates *under the base of the rail*, and notching them into the cross-ties, as proposed by Ellwood Morris, C. E.

singular splice is formed by means of a ring of wrought iron inserted in notches in the ends of two adjacent rails, which are confined in the ring by 3 wedges, one of wrought iron under the bottom, and two cast iron ones on the sides. As originally modeled, the ring was a complete circle, and the under wedge a block of wood (see dotted lines fig. 11). The joint is *suspended* by the ring *between* two cross-ties, and the rails are simply spiked down to the cross-ties in the usual way. This curious but efficient joint contains *a minimum quantity of metal*, and in practice appears to stand very well with the heavy rail and large business of the C. & A. R.R.

Fig. 11.

About twenty years ago, a large portion of the track of the Camden and Amboy Railroad was laid with a 40 lb. rail, with "*link plates*," covering the joints on the *outside only*, as shown in the sketch, (see fig. 12.)

Fig. 12.



These "*link plates*" were about 5 inches $\times$ $2\frac{1}{2}\times\frac{3}{8}$, secured by two $\frac{3}{4}$-inch bolts—they formed in no sense what are called "*fish plates*," (though in a recent discussion in England they have been so called,) since they added nothing to the strength of the joints, and were merely employed as "*a link*" to keep the rails in place lengthwise.

They have not been used in relaying that railroad, but have been supplanted by the "*ring joint*," and others.

General Remarks.

We may perhaps generalize, so as to arrange all railroad joints into two classes.

1st. *Supported Joints.*

2d. *Fished Joints.*

The first are usually formed by chairs or plates, and rest upon a single cross-tie, by which they are "*supported ;*" such joints add no strength to the ends of the rails.

The second are now formed either by "*fish pieces*," or "*long chairs*," which are all designed not only to give smoothness and firmness to the joints, but to add also to the strength of the rails at their point of severance. In the present state of our information, there is no question that the best railroad joint is a "*fished joint*," but in what particular manner it should be *fished* so as to combine in a due degree strength, durability, and economy, *is yet an open question.*

In addition to having a good joint, its relative place in the track is also of importance, and on this point there is much difference amongst engineers.

Some insist that both joints in opposite lines of rails should rest on the same cross-tie, or be "*opposite joints*," notwithstanding this duplicates the weakness of foundation ; while others insist that the joints in all cases should be "*broken*," or placed opposite the middles of the bars of the other line.

I have no doubt that "*breaking joints*" forms the proper system—and was once compelled to alter a half mile of track from "*opposite joints*"

to "*broken joints*," in consequence of the trouble of keeping it in repair, while the opposing joints rested upon the same cross-tie, which difficulty vanished as soon as the joints were "*broken*" or alternated, so as to bring only one joint on one cross-tie.

"*Broken joints*" have been, *and still are very successfully*, used upon *three* of our leading railroads—the Baltimore and Ohio—the Pennsylvania—and the Reading—while the Erie R.R., which was originally laid with "*opposite joints*," is now being gradually changed, much to the advantage of the road, the comfort of the passengers, and the benefit of the rolling stock.

To show the importance of this question of joints, I may state on the authority of Col. Franklin Hewson, Engineer of the Upper Schuylkill railroads, that the heavy cast iron chairs used upon the Reading Railroad, have all disappeared under 8 millions of tons of traffic; while the cast iron chairs of the pattern shown you (weighing 33½ lbs. each), indicate that they will be destroyed by the transit of little over 6 millions of tons of trade, upon the Upper Schuylkill railroads.

In concluding this subject, I must remark that the expansion and contraction which *theoretically* amounts to one-fifth of an inch (in our climate,) in a 20 feet bar, seems to have been successfully ignored *in practice*, by Norris's chair cast upon the joints in place—by Barlow's saddle rail, which is firmly riveted to under-plates at the joints—by Col. Hewson's parting rod—and by all the forms of compound rails.

While we must admit that change of length in wrought iron must always follow change of temperature, we cannot deny that practically it has far less importance than has usually been ascribed to it, and that the refined instructions given upon this point to track-layers, by many engineers, are of very little moment. *Some* provision must of course be made for change of length by change of temperature; but practice teaches that this provision may be less in extent than has generally been deemed necessary.

Mr. Teas, of Wilmington, Delaware, who is practically engaged in laying down Trimble's Wooden Splice, patented March 10, 1855, (fig. 9,) described this joint at length, and stated that before offering it to other roads, it had been most effectually tested during *six years* upon the Philadelphia, Wilmington, and Baltimore R.R., and that it was now in successful use upon the Baltimore and Ohio, Northern Central, and other important railroads.

He stated that this splice cost 80 cents per joint, and that the patent fee was $10 to $20 per mile. White oak is the timber preferred for the fish piece.

J. Dutton Steele, C. E., described at length the combined joint devised by him, and used at present *exclusively* upon the Reading Railroad, with very satisfactory results.

He laid much stress upon the importance of suspending the joints *between the cross-ties*, and expressed the belief that the Reading R.R. Co. were the first to adopt this great improvement on a large scale.

He expressed the opinion that while the strain upon the rails from the rolling load, was halved by making joints *between ties*, two ties were brought into play as supports instead of one; thus doubling the tie

resistance, and making the joint *four times as strong* as if carried in a chair upon a single tie.

He illustrated this at length, in some able practical observations upon the manner of producing fractures of rails in work.

He called attention to the simplicity of his combined joint, and the ease with which it could be put together, or removed from the track, piece by piece—a point of great importance in the maintenance of railroads of heavy trade.

He thought that the introduction of wood into the joints was important, as giving elasticity, and that the mode of connecting the three parts was of consequence, since the irregularities of dimension in rails made it indispensable that the fastenings should admit of being drawn up, so as to accommodate irregular dimensions, and at the same time grip the rail with sufficient strength. *This splice costs one dollar per joint* (fig. 10).

He had laid upon the Reading R.R., one mile of track with Trimble's splice, and another mile with Reeves & Co's. long chairs, and said that in two years' use the rails of the former were decidedly more worn than those of the latter, laid with long chairs and joints *between ties.*

He explained the mechanism of the action of trains on the rails, saying that the rail upon which the train stood or moved was firmly held by its weight, like a fixed beam, while the forward rail, towards which it was advancing, remained loose, and received a violent shock when reached. He had noticed that on double track railroads, breakage of rails usually occurred forward of the motion of the train, or up track one way, down track the other, and this breakage was usually a foot or two from the joint.

He stated that it was absolutely necessary to provide for expansion, and that he had been compelled to take up and alter tracks too tightly laid. In one instance the track sprung up vertically *one foot*, and shot out sidewise *two feet.*

He never laid any tracks with opposite joints *two on the same tie;* thinks that plan is vicious, and in fact impracticable, except on straight lines, and that it has few if any advocates at the present day.

He stated that owing to some change taking place in the state of integration of the iron rails in use, double-headed rails worn out on top and then turned, lasted but a brief period.

He had also noticed that rails worn in curves, when turned, went to pieces under the traffic with astonishing rapidity, and stated that merely removing and relaying again *the same rails in the same position,* caused them to wear out with much increased rapidity.

He expressed the opinion that an allowance in some form was necessary for expansion, of $\frac{1}{4}$th to $\frac{3}{8}$ths of an inch in rail bars 24 feet long.

Mr. Steele, drawing from the resources of his great experience, illustrated these and other points relating to railway joints, in a very forcible and satisfactory manner.

Frederick Graff, C. E., (just returned from Europe,) was called on by the President, and stated that in England, and upon the Continent, the "*Fished Joint*" was the favorite joint, and Locke's double-headed rail the favorite rail.

That the joints were usually laid upon the same cross-tie—though the newer lines were introducing the alternate system.

The Swiss seem to have paid little regard to the English or Continental examples, but both in their roads, and especially in their rolling stock, they have followed the best *American models.*

Solomon W. Roberts, C. E., stated that there was great difficulty in selecting the best, from amongst the very numerous plans offered for the joints of railways—and he illustrated this by an anecdote relative to the celebrated engineers, Stephenson and Brunel—the former, the great advocate of *detached bearings*, admitting as the result of his experience, that in the end *continuous bearings* were the best; while Brunel, after long practice with *them*, had declared in favor of *the detached system!* For his part, he was now using Reeves & Co's. neatly made wrought iron chairs, and thought them as good as any other joint.

He spoke of the difficulty of securing a fit of iron to iron, and of the disappointment often experienced in results, saying that he had once laid a railroad in apparently the most permanent possible manner, with stone cross-ties upon heavy and well drained ballast, but it did not stand, and he had to resort to wooden cross-ties, really more perishable, but which made a better track than the permanent materials used at first.

He explained the mode of cutting and preparing under his own eye in Wales, the original rails of the Reading Railroad, which have stood very well, and thought it would be a great improvement to modern rails if equal pains were taken with them.

Mr. Roberts expressed his willingness to learn and to adopt well tested contrivances, but did not seem to attach much importance to any of the modern forms of railway joints.

Prof. F. Rogers, C. E., remarked, that although the method of laying the track on the English railroads was familiar to the engineers, it might be interesting to some of the other members to know that on the majority of those roads it differed from the plan adopted in this country.

The rail used is generally double-headed, (Locke's rail,) and is secured to the cross-ties, not by hook-headed spikes, but by a chair at each tie, the rail being wedged into the chair by iron or wooden wedges.

It is extremely difficult to keep these fastenings tight, so that they require continual attention.

On the older railways, the joint chairs are of the same form as the other chairs, but usually rather heavier.

In the later examples in England, fish plates applied on both sides of the vertical web of the rail, are frequently used, the joint being placed sometimes *on a tie*, and sometimes *between two.*

He had seen in Germany in the spring of 1854, a splice made by applying a piece of timber to the outside of the rail on the same principle as Mr. Trimble's splice, which has been described. The two inventions are believed to be entirely independent of each other.

The superiority of the permanent way of the Continental roads over those of our country, and even England, which was undoubted, Prof. R. thought was to be attributed to the great care taken in laying the rails, and to the constant supervision of them, rather than to any peculiar mode of fastening or construction; as with us, this part of the construction which is tedious and disagreeable to the engineer in charge, is often left too much to the mercy of the ordinary workmen.

The smoothness of these roads may be illustrated by the fact that sewing and reading are frequently the amusements of the passengers on the long express routes of Central Europe; and they may either be indulged in without injury to the eye, or inconvenience from the motion.

He thought that the unnecessarily large spaces left between the ends of the rails, were a fruitful cause of destruction to the rails and fastenings.

He also threw out the important suggestion that it might be found advisable to make the rails absolutely continuous in stretches of a hundred yards, or thereabouts, so as to reduce the number of joints in a single track railway to about 35 per mile; and with this small number of joints, he thought we could afford to expend enough upon each, to make them compensate effectually for temperature, and also have an adequate strength to carry the wheels smoothly over, and to resist all lateral displacement, so as to make these comparatively few joints *in fact practically perfect.*

W. Parker Foulke, Esq., concluded the debate, by remarking upon the importance of these practical discussions to the public, and thought that in favor of all well tried devices forming parts of railway structures, and intended to promote the public safety and convenience, all the influence of the Institute should be exerted.

On motion of Charles E. Smith, the meeting adjourned for one week, when the discussion of Railway Joints will be resumed.

—

At an adjourned meeting (June 25,) the discussion was continued, Dr. B. H. Rand, Secretary, pro. tem., President Cresson in the Chair.

Charles E. Smith, exhibited a model 16 feet long, showing a section of track laid with miniature U rails, on a 5 feet gauge—to represent the yielding nature of the ground, the rails are laid on cross-ties of india rubber—four joints were made. 1. Without any chair or under-plate, the rails meeting directly on a tie, and being confined by hooked spikes. 2. With a short under-plate upon a tie. 3. With a long under-plate covering three cross-ties, but merely loosely placed. 4. With a long under-plate like No. 3, but firmly riveted to the base of the rails, as in fig. 8. Upon this model track a heavily weighted four-wheeled carriage was placed.

When this carriage was moved along, the action of the joints was beautifully illustrated. No. 1 sunk into the elastic tie, and made a palpably bad joint. No. 2 was better, but still sunk too much. No. 3 yielded less, but yet very perceptibly. While No. 4 did not yield at all, and move the car fast or slow, it appeared to be quite as strong as the rest of the rail.

With this model he had closely studied the question of joints, and he had reached the conclusion, *that, with equal tie spaces, the weakness there was precisely 50 per cent. of the strength of the rail.*

He therefore provided an iron splicing or fish bar, with a projecting rib, and attached it underneath the rails, whether U or T, by riveting to the base (see fig. 8). This fish bar covered not less than 3 cross ties; it had just half the sectional area, and half the strength of the ordinary 60

lbs. rail usually employed in this country, and in practice he had found it *entirely successful.* It had been used upon the mountain division of the Pennsylvania Railroad, on the heavy grade under pushing engines of great weight—on a railroad in Georgia—on the Camden and Atlantic Railroad—and on the Mine Hill R.R., (a heavy coal road,) one trial mile had now been down for some years, *and had carried seven millions of tons of coal, without impairing the joints*—this important fact was vouched by the President of the Institute, who is also the chief officer of that road. *This splice costs $2 per joint,* (fig. 8.)

Mr. Smith went on to describe the mechanism of the strains to which railroads are subjected, and considered it self-evident that the sinking of joints and joint ties, was the result of vertical weakness, and could be gotten rid of entirely by augmenting their strength just 50 per cent. by some substantial splice.

He thought there were some objections to Barr's fish plates, and that Trimble's wooden splice would not be entirely satisfactory.

I. R. Trimble, C. E., stated that in 1836, when placed in charge of the Baltimore and Susquehanna Railroad, he had just returned from England. He had found their rail tracks much smoother and better than ours, but no settled system of joints. He early noticed the great defects of our railroad joints, and gave the subject very close attention. He soon perceived that it was idle to attempt an effectual strengthening of the joints, *by any short splice, or by any form of chair whatever, depending upon a single cross-tie.* He saw that three cross-ties at least must be covered, and their united strength of foundation brought in aid of the joint. He made a model and also tried a joint, *suspended between two ties,* now a favorite plan, then first attempted (he believed) by himself.

His first idea was to strengthen the joint by a substantial block of wood, capable of furnishing the requisite strength, and he tried a wooden splice underneath the rails—sinking 3 ties at the joint four inches lower than the rest to admit of it. This worked tolerably well, but owing to the inequality of depth in the foundation, it did not meet his wishes fully.

He was then called to the charge of the Philadelphia, Wilmington, and Baltimore R.R., and found it in very bad condition, especially at the joints; to these he gave his attention, and at first fished them with strong side plates, of wrought iron, which for a time made a very good road, but the bolts would not stand, though he tried both screw-bolts and key-bolts. Finally, he provided a traveling forge, and riveted up hot all the fish plates of the line. Now he supposed all was secured, and for four months it made an excellent track, but then the rivets began to break, and he was eventually forced to abandon the plan of *fish jointing with iron.*

He now recurred to the study of the wooden fish splice, and tried it in a modified form in 1850, using an iron fish plate inside, and the wooden splice outside. Finally, in 1851, he omitted the iron fish plate inside, and used the wooden outside splice alone, in the form patented by him, (see fig. 9.) He found this to furnish all the vertical strength necessary

to make the joint smooth, all the lateral stiffness required, and all the elasticity necessary to preserve the rolling stock.

This splice had now been in use *six years*, it was employed upon many important railroads, and was giving very general satisfaction.

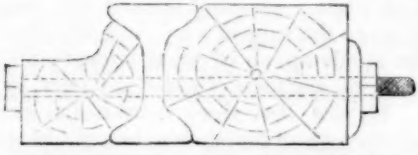
It was fully ascertained by experience, that the wooden splicing pieces outlasted the cross-ties, and that after the first general screwing up, which was found necessary to meet the shrinkage of wood, nothing more was required during the life of the cross-ties upon which the splices rested.

The track-masters whom he had consulted as to the practical working of his splice, assured him, that with it the joint-ties gave them no more trouble than the intermediate ones, and this he considered as adequate proof of the equality of strength given to the track, by the application of his wooden splices.

As engineer of the Baltimore Central Railroad, he had adopted a form for the superstructure of the track, which combined some novelties, (see fig. 13.)

The rail was to be double-headed so as to admit of turning. It was to be perfectly flat on top, and he had planned it with a flat-head of 3 inches wide—but financial considerations caused him to reduce it to $2\frac{3}{4}$ inches flat-head, $4\frac{1}{2}$ high, $\frac{3}{8}$ths stem, and 57 lbs. weight per lineal yard.

Fig. 13.



He thought a good rail should have at least 3 inches flat-head, to stand the momentum of the driving-wheels of the modern locomotive, which if bearing upon an inch wide only (as usual), exert an action superior to the tenacity of iron, and hence our rails fail so rapidly.

He intends to use this double-headed rail without any under-plates, and to abandon in this track the use of the hook-headed spike. He will use a long *outside* wooden splice at each joint (7 feet long, 4×6 inches), and *inside* wood splices ($2\frac{1}{2}$ feet, 3×4 inches,) at each joint clearing the flange, and also over every *alternate* sill space throughout the track. These will be bolted to the ties by straight spikes with square heads, and chisel points of the simplest possible form, and made by machinery.

He thought a joint thus spliced, *inside and out*, by wooden fish pieces neatly wrought to fit the hollow of the rail, would cost about $1·20 each, but that in a mile of track the cost of this improved method of laying railroads would but little exceed that of the usual imperfect plan, with wrought iron chairs.

He thought, in reference to the rapid wear and tear of rails recently noticed, that much is owing to the greater hardness of ballast and firmness of bed in our modern roads.

He remarked upon the Washington railroad, with which he is quite familiar—this line is laid with a very light rail, on a continuous bearing of wood, and the road is very imperfectly ballasted, yet it has stood better than any rail of its weight in the country.

This elastic track, this support of the rail upon a cushion of wood, is what he has endeavored to imitate in his method of splicing.

Mr. Trimble concluded with some interesting general remarks bearing collaterally upon the subject in hand.

Samuel J. Reeves thought in this discussion the momentum of the locomotive was a very material matter, and that the force acting upon the joints of a railway at the tread of the driving wheel, ought to be closely studied by our engineers in connexion with this question.

There could be no doubt that any divided bar could be so spliced—top, sides, or base—as to equal its strength elsewhere, and this could be done in several ways—the question here appeared to be between bolting or riveting on a fish plate, and the sleeve attachment formed by the ordinary chair.

He thought a neatly fitting chair, embracing as with a sleeve the base of the rail, and extending over 3 cross-ties, would be found to fish the joint in an adequate manner.

He was making a neat wrought iron chair (which was shown, and is certainly unexceptionable in its workmanship), weighing 1½ lbs. per inch forward, and which could be furnished, cut off to any length, at 5c. per lb.; at this price a joint chair, 28 inches long, would cost about $2. And this might be regarded as the price of a joint fished with a long sleeve chair on their plan.

Their 10 lb. chair was highly approved by many eminent engineers, and as an evidence of its popularity, he might mention that their orders at this moment were for over 60,000 chairs, of the pattern exhibited.

He made a number of interesting observations relative to the rails of railways, and expressed the opinion that the durability of a rail depended much upon the manner in which its work was imposed.

Thus he thought that if a new rail was worked at first with very light machinery, and then with heavier and heavier, a sort of consolidation of atoms would be produced highly favorable to the life of the rail. Just such had been the actual process to which the original rails of the Reading Railroad had been subjected, and he thought it had much to do with their acknowledged excellent wearing.

In support of this peculiar view, he stated the fact personally known to himself, that the good old rails of the Reading road, when re-rolled and put at once to heavy work, though in heavier masses now than formerly, *showed none of their former superiority over other rails.*

Prof. Fairman Rogers, C. E., thought vertical fishes stronger and better than flat fishes underneath, unless the under-plates were rolled with an attached rib as in Smith's splice, and securely riveted to the base of the rails.

He said that all the joints which had been under discussion, or which he had seen in use here, he had also seen in use in Europe; though he did not pretend at this time to decide upon their priority.

J. Dutton Steele, C. E., stated that in his experience, no form of *continuous bearing* either of wood or iron would answer for the tracks of heavy railroads—for want of elasticity, and this must be borne in mind in every plan for strengthening joints, we must take care not to make them too rigid—if we do, *they will unquestionably fail.*